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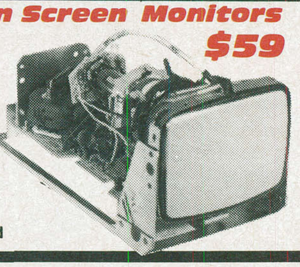
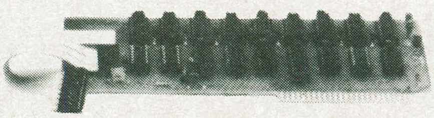
Requires Sync Separator Board



Don't hesitate to contact us on our price hotline 921-8941 for the most competitive prices in Canada!

16K RAM Card



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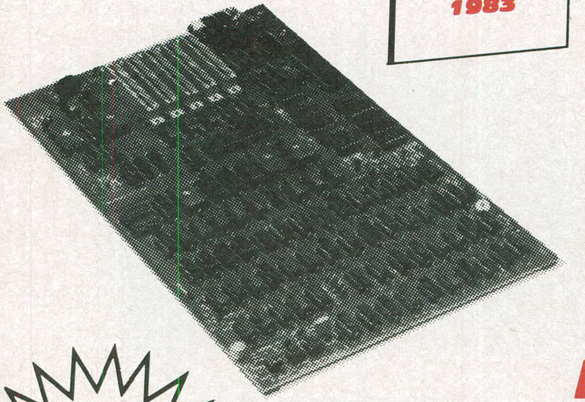

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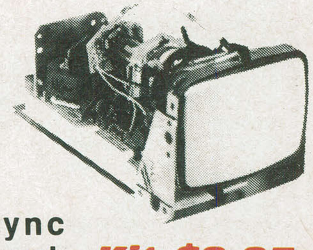

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The Magazine for Electronics & Computing Enthusiasts

ETI Electronics Today International

November 1983
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Our Cover

A look at facts and myths about robotics appears on page 18; photo courtesy of Ford Motor Co. of Canada. The Dragon 32 computer is reviewed on page 42; photo by John Rudzinski.

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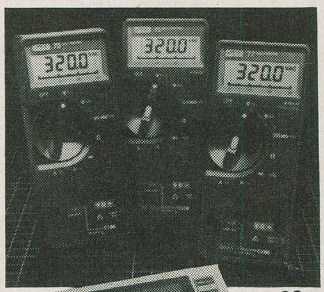

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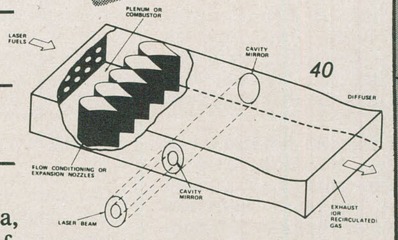

Schematic Diagram of a High Power Laser

Features

Projects

PROJECT

Columns, News and Information

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Previous issues of ETI Canada are available direct from our offices for $4.00 each; please specify by month, not by feature you require. See order card for issues available.

We can supply photocopies of any article published in ETI Canada; the charge is $2.00 per article, regardless of length. Please specify both issue and article.

COMPONENT NOTATION AND UNITS
We normally specify components using an international standard. Many readers will be unfamiliar with this but it's simple, less likely to lead to error and will be widely used everywhere sooner or later. ETI has opted for sooner!
Firstly decimal points are dropped and substituted with the multiplier: thus 4.7uF is written 4u7. Capacitors also use the multiplier nano (one nanofarad is 1000pF). Thus 0.1uF is 100nF, 5600pF is 5n6. Other examples are 5.6pF = 5p6 and 0.5pF = 0p5.
Resistors are treated similarly: 1.8Mohms is 1M8, 56kohms is the same, 4.7kohms is 4k7, 100ohms is 100R and 5.60hms is 5R6.

PCB Suppliers
ETI magazine does NOT supply PCBs or kits but we do issue manufacturing permits for companies to manufacture boards and kits to our designs, Contact the following companies when ordering boards.

Please note we do not keep track of what is available from who so please don't contact us for information on PCBs and kits. Similarly do not ask PCB suppliers for help with projects.

K.S.K. Associates, P.O. Box 266, Milton, Ont. L9T 4N9.
B—C—D Electronics, P.O. Box 6326, Stn. F, Hamilton, Ont., L9C 6L9.
Wentworth Electronics, R.R.No.1, Waterdown, Ont., L0R 2H0.
Danocinths Inc., P.O. Box 261, Westland MI 48185, USA.
Arkon Electronics Ltd., 409 Queen Street W., Toronto, Ont., M5V 2A5.
Beyer & Martin Electronic Ltd., 2 Jodi Ave., Unit C, Downsview, Ontario M3N 1H1.
Spectrum Electronics, 14 Knightswood Crescent, Brantford, Ontario N3R 7E6.

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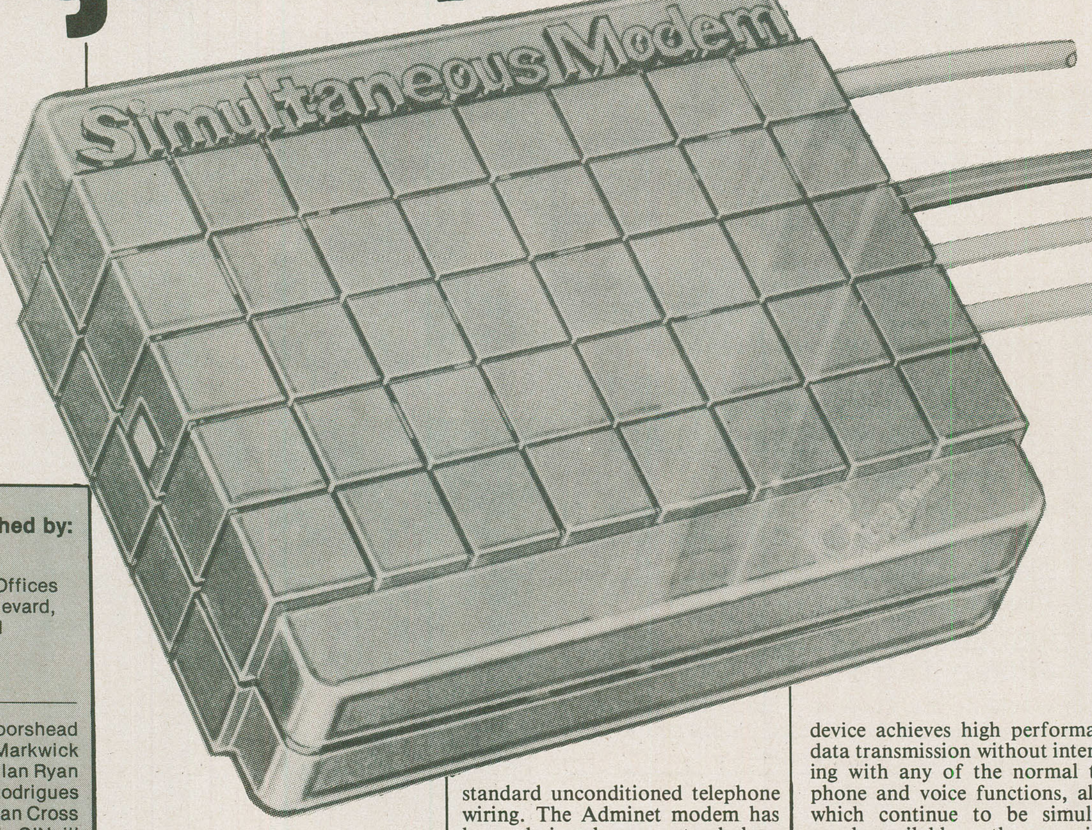

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Editorial Queries
Written queries can only be answered when accompanied by a self-addressed, stamped envelope. These must relate to recent articles and not involve the staff in any research. Mark such letters ETI-Query. We cannot answer telephone queries.

Voice/Data Modem

Adminet Inc., a new Canadian communications firm, has announced a low price, local area modem that can transmit both voice and data simultaneously over standard unconditioned telephone wiring. The Adminet modem has been designed as a stand-alone device to achieve the added feature of inexpensive digital communications on any existing analog PBX local telephone system. Capable of operating at full or half duplex at speeds up to 9600 baud, the new device achieves high performance data transmission without interfering with any of the normal telephone and voice functions, all of which continue to be simultaneously available on the same single circuit. Each PBX line to be provided with a data option retrofit requires a pair of modems. For information, contact Adminet Inc., 27 Goulburn Ave., Ottawa, Ontario K1N 8C7 (613) 563-9709.

Northern Telecom Limited's U.S. subsidiary, Northern Telecom Inc., today announced a comprehensive operating agreement with Hewlett-Packard Corporation. Under terms of the agreement the two companies will work to improve the functional capabilities and reduce the cost of interconnecting the Northern Telecom SL-1 digital business communications system or private branch exchange (PBX), and the HP 3000 Business Computer System. Three interfaces are covered in the agreement. They permit the SL-1 to switch data between the HP 3000 computer and HP terminals over existing telephone wiring.

If you're into energy, its conservation, or the use thereof, you'll be interested in the 6th Annual Energy Lifestyle Show to be held Oct. 21, 22, 23 at the Toronto International Centre, Airport Rd., Mississauga. They claim to have 100,000 square feet of "energy-efficient displays and exhibitors". Along with energy-efficient exhibitors, you can see the world's smallest twin-engine plane, home electronics and security, and home-renewal demonstrations.

Sound Switch

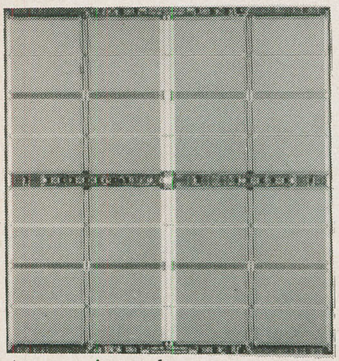
The Sound Activated Switch, a solid state electronic unit that activates lighting by the sound of human activity, is available from National Technical Systems (NTS). The plug-in unit, which is UL listed, is rated to handle up to 300 watts of incandescent light. It provides a greater measure of security than timers because it turns lights on at the sound of a doorbell or an attempted break-in, giving a much more realistic impression that someone is home. The unit is available by mail-order from companies such as Heath or Edmund Scientific. A retail network is under way.

Robotics Encoders

A comprehensive line of modular and housed shaft angle encoders geared for use in robotics is available from Encoder Division, Litton Systems Inc. The encoders are ideal for precise sensing control in the pincer, wrist, and other moving joints in robotic applications. Several configurations can be specified. The low-cost modular optical encoders consist of a photohead assembly, hub-disc assembly, and cover for easy installation. Housed incremental encoders are also available. They are ideal for control systems that require small size and high resolution. Size ranges for both the modular and housed encoders are from 1.5" to 2.2" in diameter. For additional information about Litton's line of encoders for robotics applications, contact Litton's Canadian Distributors: EP Electronics International Inc., 187 Denison Street, Markham, Ontario, L3R 1B5 (416)475-8316).

for your information

512K-Bit Memory Chip

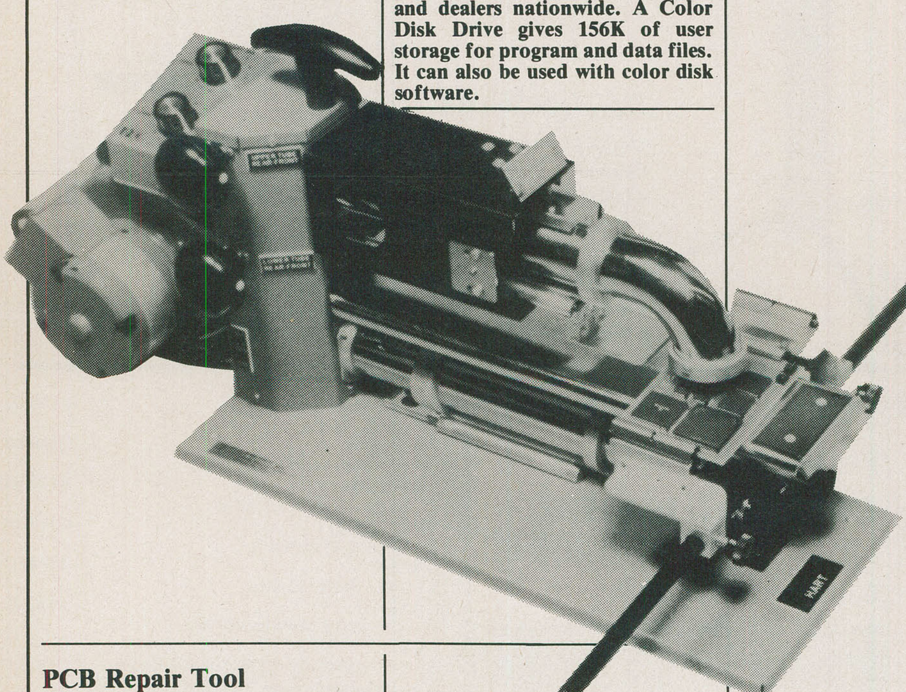


An experimental computer memory chip that can store more than a half-million bits of information, nearly twice the capacity of any chip yet reported, was described at a technical conference by engineers from IBM's semiconductor facility in Essex Junction, Vermont. The new component is a 512K-bit dynamic random access memory (RAM) chip. Since, in computer terminology, "K" stands for 1024, the chip actually holds 524,288 bits of information. It is the first complete chip ever to use an electronic technique called "plate pushing" to read data out of its storage cells. Plate pushing — previously used only in greatly simplified test circuits — produces an electrical signal nearly twice as large as that produced by conventional data reading methods. With this stronger signal, it is possible to increase the chip's density and reliability while maintaining high performance. The new chip measures 7.96 mm by 8.6 mm (about 3/8-inch square). Data can be retrieved from its storage cells in 120 nanoseconds (billionths of a second). The smallest photolithographic images in the chip's circuit pattern are just 1.5 micrometers wide, about 1/50th the diameter of a human hair.

DNR Problems

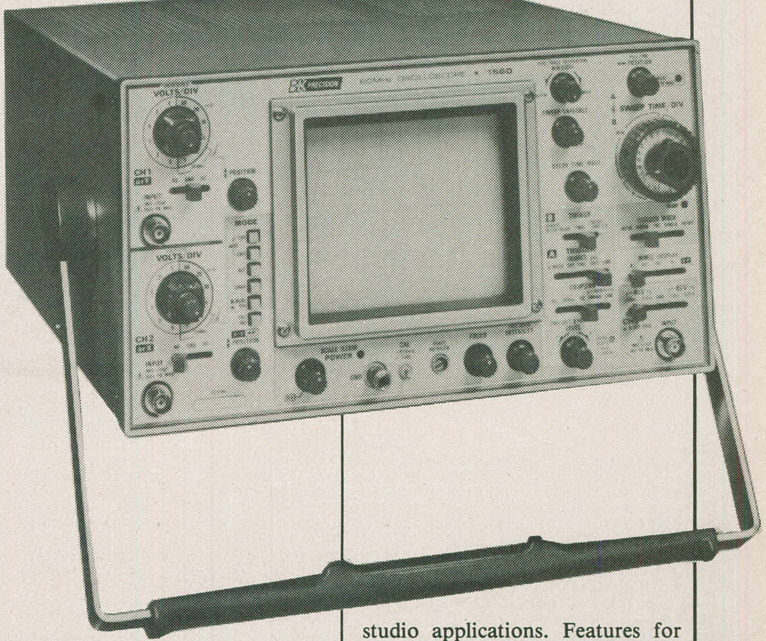
After last month's project for the Dynamic Noise Reduction project went to press, we discovered that National Semiconductor is restricting sale of the IC to high-volume manufacturers. We regret any inconvenience caused to our readers.

The Color Disk Drive from Radio Shack, a division of Tandy Corporation, turns the Extended BASIC Color Computer into a disk system at a new low price. The Color Disk #0 Kit (26-3022) for the original Color Computer is now offered for $599. It was $799. The Color Disk #1, 2 or 3 (26-3032), which requires the Disk #0, is now offered for $399. It was $599. These disk drives are available at Radio Shack computer centres and participating Radio Shack stores and dealers nationwide. A Color Disk Drive gives 156K of user storage for program and data files. It can also be used with color disk software.



PCB Repair Tool

Companies involved in repairing printed circuit boards requiring component replacement can minimize discards with Nu-Concept's HART, for "Hot-Air Replacement Terminal". The unit is said to solder and desolder on such difficult boards as multi-layer or aluminum. Just the ticket for removing and replacing chip carriers or gate arrays. PC fans can obtain more information from Tom Dvorak, Rte. 309 and Advance Line, Colmar, PA 18915, (215) 822-8400.



Triple-Trace Scope

B&K-Precision has just introduced their new 60 MHz triple trace oscilloscope, model 1560. The 1560 oscilloscope is a dual time base, delayed sweep unit ideal for troubleshooting, maintenance of video systems and computer terminals, as well as for broadcast studio applications. Features for the 1560 include: 1 mV/div. sensitivity; rectangular CRT with internal graticule and scale illumination; X10 sweep magnification; X-Y operation and Z axis input. B&K-Precision products are represented in Canada by Atlas Electronics Limited, 50 Wingold Avenue, Toronto, Ontario, with branch offices in Montreal, Ottawa, Winnipeg, and Vancouver.

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Assembled $58.00

The ZX81's advanced capability.
The ZX81 uses the same fast microprocessor (Z80A), but incorporates a new, more powerful 8K BASIC ROM — the "trained intelligence" of the computer. This chip works in decimals, handles logs and trig, allows you to plot graphs, and builds up animated displays. And the ZX81 incorporates other operation refinements — the facility to load and save named programs on cassette, or to select a program off a cassette through the keyboard.

New, improved specification.
*Unique 'one-touch' key word entry: eliminates a great deal of tiresome typing. Key words (PRINT, LIST, RUN, etc.) have their own single-key entry. *Unique syntax-check and report codes identify programming errors immediately. *Full range of mathematical and scientific functions accurate to eight decimal places. *Graph-drawing and animated-display facilities. *Multi-dimensional string and numeric arrays. *Up to 26 FOR/NEXT loops. *Randomize function. *Programmable in machine code. *Cassette LOAD and SAVE with named programs. *1K-byte RAM expandable to 16K. *Full editing facilities. *Able to drive the new Sinclair ZX Printer (to be available shortly).

If you own a ZX80. . .
The new 8K BASIC ROM as used in the ZX81 is available as a drop-in replacement chip. (Complete with new keyboard template and operating manual). With the exception of animated graphics, all the advanced features of the ZX81 are now available on your ZX80 — including the ability to drive the Sinclair ZX Printer.

Sinclair's new 8K Extended Basic offers features found only on computers costing three or four times as much. *Continuous display, including moving graphics. *Multi-dimensional string and numerical arrays. *Math and scientific functions accurate to 8 decimals. *Unique one touch entry of "key words" (i.e. basic and system commands). *Automatic syntax error detection. *Randomize function. *Built-in interface for ZX Printer. *Connects to standard TV and cassette recorder. *164 page manual included. *Power supply (9V at 650 ma) optional for $14.95. *1K of memory is included.

$119.00

Designed exclusively for use with the ZX81 (and ZX80 with 8K basic ROM), the printer offers full alphanumerics and highly sophisticated graphics. COPY command prints out exactly what is on screen. At last you can have a hard copy of your program listing and results. Printing speed is 50 characters per second, with 32 characters per line and 9 lines per vertical inch. Connects to rear of ZX81 — using a stackable connector so you can use a RAM pack as well. A 65 ft paper roll, instructions included. Requires 9 volts, 1.2 amp power supply (option extra).

Printer Paper
Single Roll C751 per roll 6.95
Package of 3 . . . . 16.95
Power Supply (500 mA) $9.95
Power Supply (650 mA) $14.95
Power Supply (1 Amp) $19.95

Etc . . .

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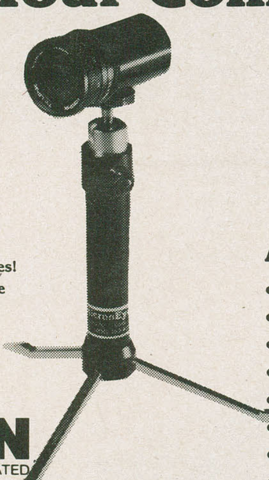

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- 128 x 256 element resolution.
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COMPLETE ZX81 BASIC COURSE - inc. 2 tapes	39.95
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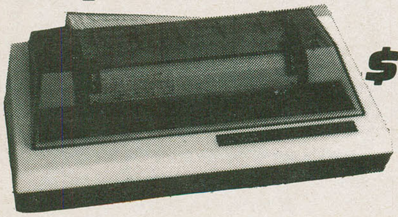
UNDERSTANDING ZX81 ROM	19.95
T/S 1000: PROGRAMS, GAMES and GRAPHICS	16.95
LEARNING T/S BASIC	23.95
THE BASIC HANDBOOK	29.95
49 EXPLODING GAMES	16.95
COMPUTER FOR KITS SINCLAIR EDITION	8.95
MASTERING MACHINE CODE ON YOUR ZX81	24.95
T/S 1000 USERS GUIDE (Vol 1)	16.95
EXPLORERS GUIDE TO THE ZX81	16.95
ZX81 POCKET BOOK	16.95
GETAWAY GUIDE	16.95
GETTING AQUAINTED WITH YOUR ZX81	16.95

Hardware

ZX81 Ass.	58.00
ZX Print	119.00
64K RAM (Memotech)	199.00
Orion 64K	149.00
32K RAM (Memotech)	119.00
16K RAM (Sinclair)	59.00
Power Supply (650 M.A.)	14.95
Power Supply (1 AMP)	19.95
Keyboard (uncased) - 47 Keys, Assembled no soldering req.	109.95
Metal Case for above	29.95
Memopak Centronics Type Parallel Printer Interface	119.00
Memopak ZX81 Keyboard	139.00
Memo Calc	79.95

*** Interface for any serial printer & 4 cassette recorders; includes plugs, cords and a detailed manual.**

CP-100-A Seikosha Graphic Printer



$450

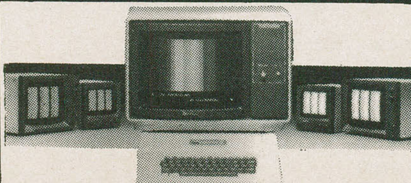
- **5x7 Dot Matrix**
- **Parallel Printer**
- **8 Bit ASCII**
- **80 Columns**

Interface Cards & Cable For Apple II **$119.00**
Memotec Interface for Sinclair **$149.00** Cable **$35.00**

TTX™ 1014 **$749.00**
Reliable Daisy Printer

CP80 DOT MATRIX
$495.00
Same as Epson 80

Electrohome Monitors & Accessories



EDM926/B&W 9" Black & White monitor	**$159.50**
EDM926/P31 9" P31 Green Monitor	**$169.50**
EDM1226/B&W 12" Black & White Monitor	**$179.50**
EDM1226/P31 12" P31 Green Monitor	**$189.50**
ECM1302-1 13" Color RGB Monitor	**$389.00**
ECM1302-2 13" Color RGB Monitor Hi Rez.	**$450.00**
I-1302 NTSC Interface for ECM1302 for Apple II Computers (1 year warranty from Electrohome)	**$ 69.50**
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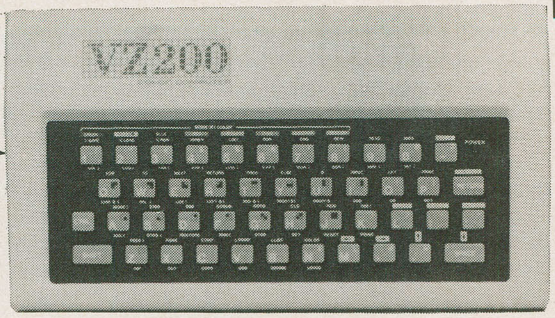

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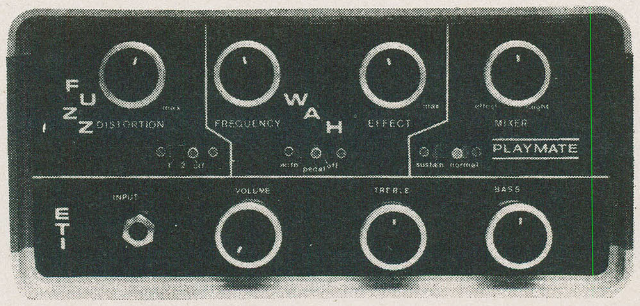
Playmate Guitar Effects/Amp

The sounds of the superstar in your own room – or in the middle of a field! The PLAYMATE will help you on your way. Design and development.

by Phil Walker



THE PLAYMATE is a small practice amplifier giving a few watts output while also providing some of the basic effects used by many musicians. It is ideally suited to those who do not carry all the various effects units around in their guitar cases, but would like to be able to practise at odd moments or in out-of-the-way places.

In addition to the amplifier and standard tone controls, etc, various distortion and wah-wah effects are possible. As a by-product of the circuitry a sustain effect is also possible.

The sound output is provided by a small internal loudspeaker and the whole module is powered from a small power adapter or batteries. An external foot pedal could be used with the wah effect if required. This consists of a variable resistor and a couple of other resistors to provide the necessary control current. The internal control is still active at this time and can be used to set an operating range.

The Circuit

The circuit is generally straightforward. It consists of an input buffer with a gain of about 50, followed by a signal compression stage which reduces the dynamic range greatly in order to feed the effects circuitry at a constant level. The effects consist of a distortion-inducing stage for fuzz and a variable band-pass filter for the wah wah. After the effects stages, the dynamic range of the signal is restored to normal before being fed to the mixer, tone controls and power output stages.

The input buffer consists of a single 3140 CMOS op-amp whose gain is set at 48 by R2, R3. The following dynamic range compressor consists of one part of a LM13600 dual transconductance amplifier. The gain of this device is a function of the amplifier bias current, the input diode current and the load resistor. The output buffer of the device is used here as a peak detecting rectifier which charges a capacitor (C3) to the peak value of the output signal less two base-emitter drops (about 1V4). If this voltage is greater than about 0V7, the resulting current flowing through the input linearising diodes causes the effective stage gain to decrease and keep the output level constant.

Distorting The Facts

Distortion effects in this project are of two types. The first is mainly even-harmonic, generated by half-wave-rectifying the input, inverting it and then mixing it with the original signal, allowing a range of no distortion to complete frequency doubling. In addition to this, overload type distortion is provided by a high gain clipping amplifier using non-linear feedback (IC3a,3b).

Wah wah sound effects are produced by a current-controlled state variable filter. The control current determines the centre frequency of the pass band, while a two-gang variable resistor sets the bandwidth and compensates for inevitable gain changes.

Tone controls are of a standard type and use frequency-selective feedback networks around an op-amp. The following power amplifier has been designed to have a low quiescent current. This is important if batteries are to be used, as many amplifiers of the IC variety take 30 mA or more, or are designed for single rail working.

The LM13600

This device is used for two functions in this project. One of these is the compressor/expander while the other is the wah wah. In both of these, use is made of the fact that the gain of the device is dependent on the amplifier bias current and the linearising diode current (provided that the input current is less than half the diode current). In fact, the output resistor also determines the gain but is not so easily varied.

If the diode current is zero, then the manufacturers' data sheet shows that the transfer function of the device is:—

$$I_{out} = \frac{I_{abc} \times q}{2KT} \times V_{in} = \frac{I_{abc}}{26 \times 10^{-3}} \times V_{ir}$$

If the diode current is not zero and the signal current is less than $I_{D/2}$ then the transfer function is:—

$$I_{out} = \frac{2 \times I_{abc} \times I_s}{I_D}$$

where
I_s = signal current
I_{abc} = amp. bias current
I_D = lin. diode current
I_{out} = output current

If we use resistors for input and output, it can be seen that the voltage gain of a stage using this device can be controlled easily by use of the bias and linearising diode currents.

Figure 3 shows the basic circuit for a voltage amplifier and from it we can show that the output voltage V_o is dependent on the bias and diode currents.

$$V_o = \frac{V_{in} \times 2 \times I_{abc} \times R_L}{R1 \times I_D}$$

$$I_{in} = V_{in}/R_{in} \quad \text{Therefore}$$

and the gain $$\frac{V_o}{V_{in}} = 2 \times \frac{I_{abc}}{I_D} \times \frac{R_L}{R1}$$

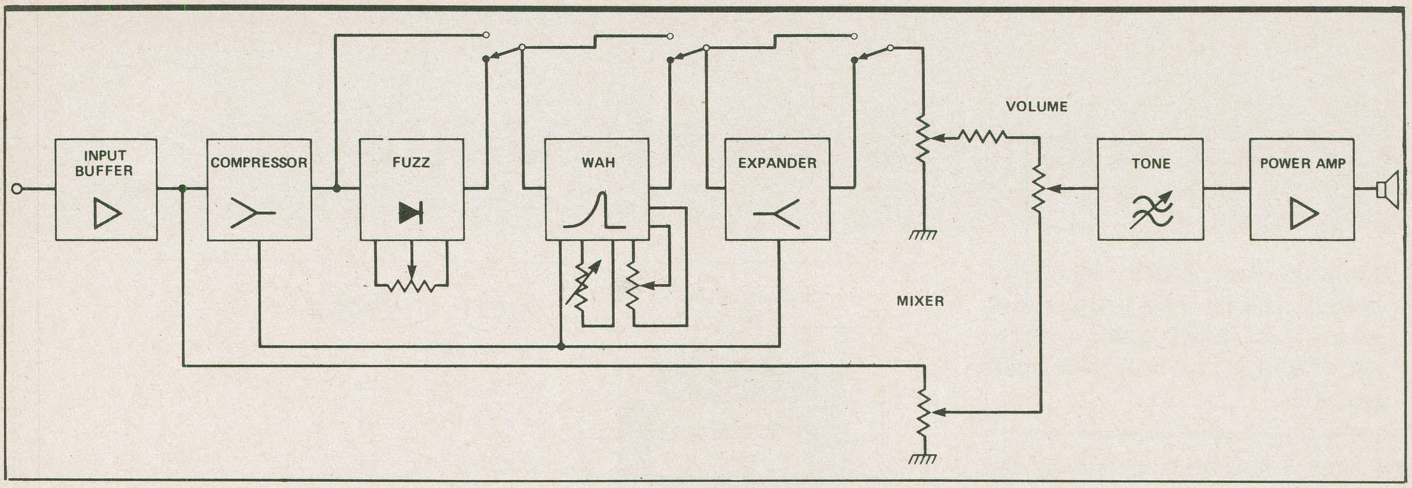


Fig. 1 Block diagram of the Playmate.

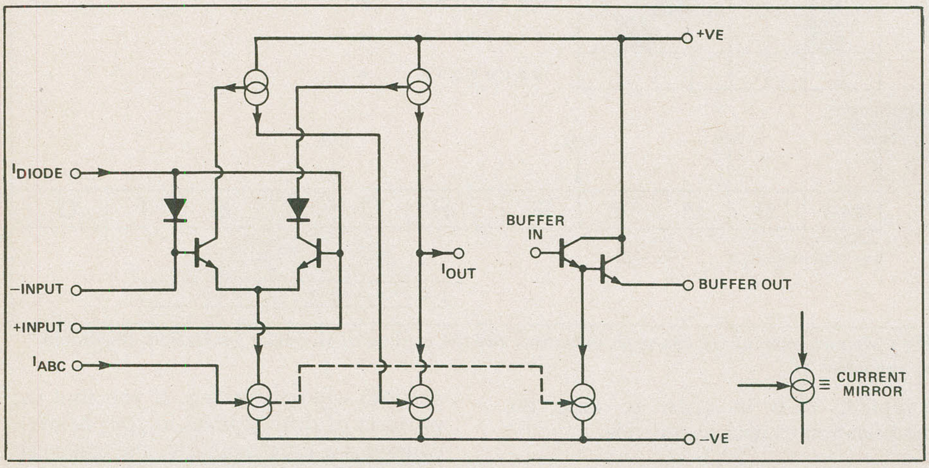
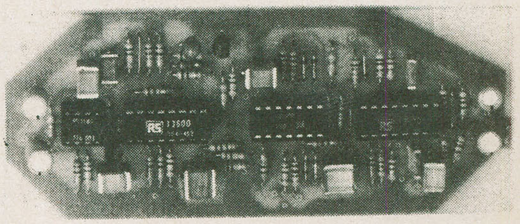
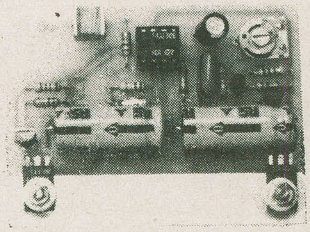
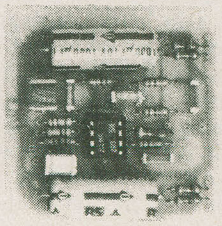


Fig. 2 Internal circuitry of the LM13600 — an operational transconductance amplifier!







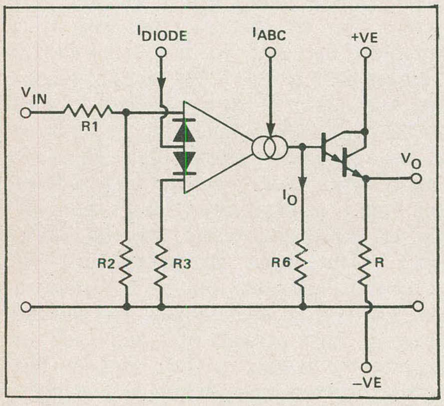


Fig. 3 Basic voltage amplifier circuit.

Compressing With The LM13600

Figure 5 shows the circuit used in this project to compress the dynamic range of the signal input. For very small signals I_D is virtually zero and the amplifier operates with a very high gain. As the signal increases, the output peak voltage will reach a level sufficient to charge the capacitor C to about one diode drop. If the input signal tries to increase further, the resulting current into the input diodes will cause their impedance to fall, thus increasing the attenuation of the input and maintaining a constant output level.

At any time the current flowing into the diodes is:—

$$I_D = \frac{2 \times (V_o - 3 \times 0.7)}{R2}$$

The 3 x 0.7 represents the voltage drops associated with the base-emitter junctions of the output buffer transistors and the voltage drop of the linearising diodes. This voltage does vary with temperature and current, and since another control current is required for the expander function, this is derived by using a resistor and common base transistor. The configuration gives a current output which tracks the compressor control current very closely, since it has the same number of junctions in series.

The LM13600 As An Expander

If the current produced by the above circuit is fed into the bias current input of a virtually identical stage while the diode current is held a constant, then the voltage gain equation above shows that the gain of the circuit will be increased as the current increases. Moreover the product of the two gains will be constant giving an invariant overall signal transfer function.

Continued on page 66

ZX81 User-Defined Graphics

PROJECT

To make your ZX81 a whole lot better, we present a project that gives 16K RAM pack owners the facility for user-defined graphics.

THE RESTRICTIONS imposed by the Sinclair defined character set can considerably reduce the impact of many programs and the attractions of having user-definable graphics are apparent. While several manufacturers supply modules to expand the character set, the cost must be a rather daunting prospect to the impecunious '81 owner.

It is possible, however, to obtain user-definable graphics on the 16K ZX81 for a total expenditure of less than a few dollars and some clever work with a soldering iron! It must be said, however, that this is not a project for the faint-hearted, involving as it does a certain amount of modification and soldering within the computer; it also renders the computer unusable without the RAM pack.

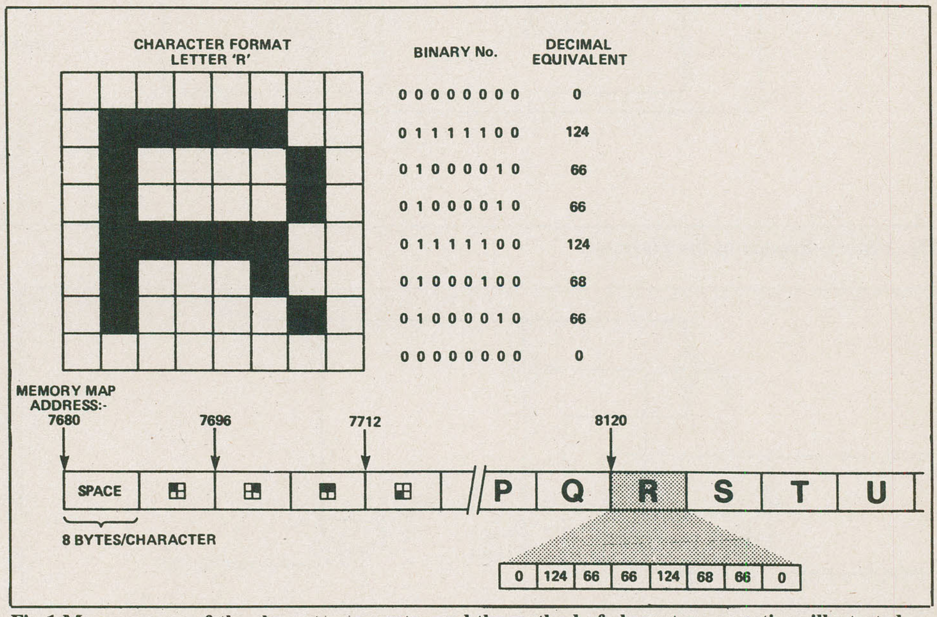


Fig 1 Memory map of the character generator and the method of character generation, illustrated by the letter 'R'.

Principle of Operation

In normal operation the pattern of each character is defined by eight successive bytes in the ROM. Each byte represents the display for one of the eight lines of the character, and each binary bit one dot of that line: Fig. 1 clarifies the way that this works. As there are 64 characters, a total of 512 (64 x 8) bytes are required, and these are located at the top of the ROM from addresses 7680 to 8191 (1EOO to 1FFF in hexadecimal). An examination of these addresses reveals that the character generator is being addressed exclusively when lines A9 to A12 are high.

The additional circuit operates by detecting when these four lines are simultaneously high with the ROM chip select line, and instead of allowing the ROM to be switched on, the internal 1K RAM is activated (this is not normally used when the 16K RAM pack is attached). This can then be filled with characters of the programmer's choice. The circuit diagram is given in Fig. 2.

Construction

The circuit is constructed on a PCB as shown in Fig. 3. Use fairly thin (insulated) wire, preferably with colour coding, for the leads between the PCB and computer. The length of the leads will need to be adjusted carefully during connection to the computer PCB in order to keep the modification as neat as possible.

Installation And Computer Modifications

To open the computer, remove all leads and accessories and then peel off the rubber pads on the underside of the computer, taking care to ensure that the adhesive film is removed with the pads. Now remove the five Phillips screws visible on the underside of the computer; note that these are of different lengths and *must* not be mixed on re-assembly. The base of the computer can now be lifted away to reveal the computer printed circuit board held in place by a further two Phillips screws, which must also be removed. The board is still attached to the case through the ribbon connector and should be carefully folded over the keyboard when you want to turn it over, since the ribbon connector is not easy to disconnect or reconnect.

The positioning of the switch does need to be thought out fairly carefully in order to ensure that it does not foul anything. Providing the switch is not too big, it should fit through the top of the case. Just in front of the RAM pack, towards the centre of the computer offers the most room, but do make sure before drilling the hole that it will all go back together (including the RAM pack connection) without fouling. If you find the prospect of drilling holes in your beloved computer a little daunting, the leads can be brought out through one of the existing holes to a floating switch.

The addressing of the RAM and ROM chips is performed in a slightly different way by the computer and it is therefore necessary to disconnect the 10 address lines to the RAM chip(s), reconnecting nine of them to the (A0' to A8') ROM chip address lines and the tenth to either a ground or a logic high. This cannot be done easily from the underside of the board, as the address tracks servicing the 1K RAM also service the 16K RAM pack. The most straightforward (if somewhat inelegant) solution is to remove the RAMs from their sockets, to bend the relevant legs through 90° and then to replace the RAMs in their sockets, but with 10 of the pins sticking out at right angles. It is now necessary to solder the address leads to these legs and into the computer PCB – Figs. 4a, b, c and d give details.

Spot Your RAM

Before doing this, it will be necessary to decide whether your particular ZX81 is of the 2114 RAM or 4118 RAM type. The former consists of two separate chips as shown in Fig. 4a; the latter has only one and the position of this is shown as a dotted outline. Identify each of the address

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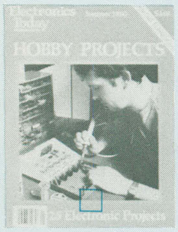

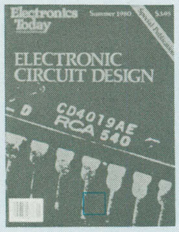

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pin numbers from Fig. 4d and run a lead from this to the relevant computer PCB hole as shown in Fig. 4c. In the case of the 2114 type it is also necessary to run leads between the two ICs. If you find difficulty in soldering directly to the IC pins, it may help to have a very thin strip of Veroboard pushed over the pins and solder to this. The leads to the switch can now be soldered into place.

Figure 5 shows the nine connections to be made to the other side of the computer board; the letters for each connection correspond with those of Fig. 3. Resistor 'R28' is removed from the computer PCB and the ROM chip select input and output connections are made through the resulting holes as **shown**. Figure 5 also identifies the RAMCS' track, which must be (carefully!) cut through. The PCB fits under the keyboard by the side of the heatsink.

Testing and Reassembly

It is worth quickly testing the computer at this stage. First, however, check, check and check again that all the joints and connections are correct and that there are no solder bridges between tracks.

Place the RAM pack in position and connect the TV lead and power supply lead. With the switch in 'normal' mode the computer should operate quite normally. In 'user' mode a regular pattern should cover the screen (each space now calling up the same random character). The program given below can be entered in 'normal' mode and run in 'user' mode to ensure that the modification is functioning correctly:

```
10 SLOW
20 FOR N=1 TO 64
30 PRINT CHR$ N;
40 NEXT N
50 FOR N=7680 TO 8191
60 POKE N, 255
70 NEXT N
```

When run in 'user' mode the screen should suddenly black out, apart from the top two lines, which should then progressively fill one character position at a time from left to right, each individual character filling from top to bottom.

Reassembly of the computer is simply a reversal of the disassembly procedure. Ensure that no leads are trapped between the pillars and the board and that the correct screws are used; short ones at the front, long at the back.

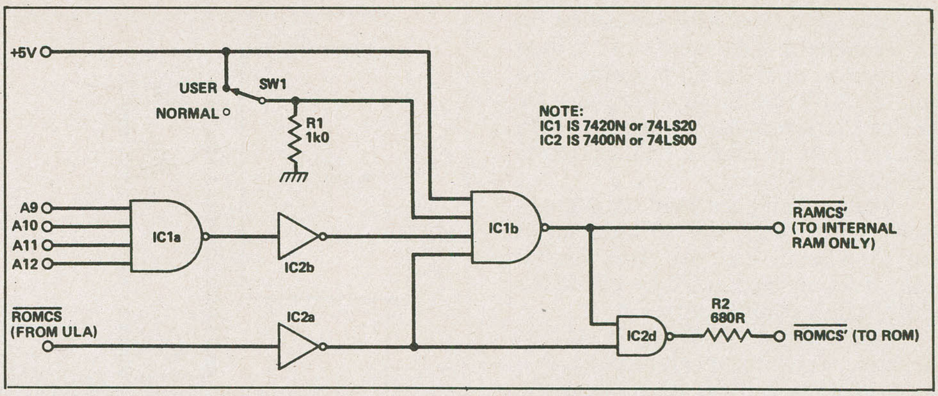


Fig. 2 Circuit diagram of the user-graphic modification.

How it Works

The inputs of the quad NAND gate 1C1a are connected to the four address lines A9 to A12. The output of this gate is inverted (using the NAND gate 1C2b with its two inputs connected together) and used as one of the four inputs for 1C2a. The third input is provided by the switch, which in 'user' mode supplied a high and in 'normal' mode a low. The fourth input is held permanently high.

Thus, when the switch is in 'user' mode and the ROM and the character generator are being addressed, all the inputs to 1C1b will be high and the output will be low: in any other circumstances the output will be high. This, therefore, satisfies the condition required by the RAMCS' line to the internal 'user' RAM.

The output of 1C2d provides the new ROM chip select line (ROMCS') by performing a logical NAND between the new RAMCS' output and the inverse of the ROMCS input from the ULA. Thus, when the user RAM is being selected, the output will always be high, and when the RAM is not being selected the output will copy the ROMCS input.

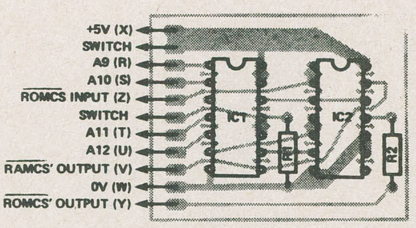


Fig. 3 Component overlay for the offboard components. The letters correspond to Fig. 5.

Parts List

Resistors (all ¼W, 5%)

R1	1k0
R2	680R

Semiconductors

1C1	74LS20
1C2	74LS00

Miscellaneous

SW1	SPST miniature toggle or slide switch
PCB	

Operation of User Graphics

It is unlikely that you will want to redefine all 64 of the available characters and the most likely requirement will be to have four or five special characters among the existing ones. As it is not possible to display both the Sinclair graphics and the user graphics at the same time, the simplest solution is to copy the Sinclair graphic set into the user RAM, and then to select some little-used primary characters and redefine them.

The exact way that this is done can vary, but my usual approach is to copy the Sinclair graphics into the user RAM at switch on. Listing 1 gives a short program (using machine code) to achieve this. When entering the REM statement (line 1) it must be entered exactly as listed. The outlines of the graphic characters have been added to clarify which symbols to use, and don't miss the three spaces in line 1 which require keying in. The keyword in line 1 is entered by first typing THEN (shifted 3), followed by GOSUB and deleting THEN using the Edit functions, but leaving the GOSUB intact. As a quick check that the line has been entered correctly, PEEK 16526 should return 118. The program borrows some of the unused computer RAM to temporarily store the 512 bytes read from the ROM and should not, therefore, be used as part of a larger program, otherwise this may be overwritten and corrupted. If this is a problem, the program can be written entirely in BASIC and listing 2 gives such a program.

Having thus copied the Sinclair graphics into the user RAM, each program can then amend the characters as required and preferably restore the original ones at termination.

Listing 3 gives a program enabling up to 10 new characters to be defined with the aid of a visual display and the information stored in the REM statement of line 1. Only the primary characters (with their inverse) can be redefined and these are the first 64 characters of the list on page 181 of the Sinclair manual. When all the characters have been defined and "FINISHED?" is answered with "Y",

the program deletes itself, excepting the REM statement. This can then be used as the first line of the main program and a call for USR 16514 will exchange the Sinclair characters with the new characters required; a further call of USR 16514 will exchange them back.

When entering the REM statement of listing 3, it is important to use noughts and to have exactly the right number (166). This can be checked by PEEKING 16680, which should return 118.

This program (ie listing 3) requires the machine code values given alongside it to be POKED into the REM statement. Listing 4 gives a suitable program for doing this and this should be entered and run immediately after entering the REM statement. All of this program (except the REM statement) may then be deleted and the rest of listing 3 entered.

If more than 10 characters need to be defined, it will be necessary to add 10 further zeroes to the REM statement for each extra character required; the final address (currently 16671) in line 320 will have to be increased by 10 for each extra character, as will the value held by the two bytes in addresses 16561 and 16562 (currently 16681). This latter value is held in the usual Z80 manner, ie. low byte first and high byte second. Having added on the required number of tens to 16681, divide by 256 to give the high byte (being the whole number part of the result) and multiply the remainder by 256 to give the low byte. For example, 16691/256 = 65.19922. Now 0.19922 x 256 = 51, so we have to POKE 16561, 51 and POKE 16562, 65.

Because the graphics are completely unaffected by RUN, NEW, LOAD, and so on, it is also possible to enhance many of your existing games and programs by redefining specific characters used in the game before loading the program. Thus chess games using I, K, Q etc can have proper chess symbols, missiles can magically turn from As into Cruise look-alikes, and so on.

```
   1 REM "  "5 2) 2 GOSUB  TAN
   2 POKE 16522,80
   3 LET U=USR 16514
   4 PRINT "SWITCH TO ""USER"" A
ND PRESS ""CONT"""
   5 STOP
   6 POKE 16522,30
   7 POKE 16519,80
   8 LET U=USR 16514
   9 POKE 16519,30
```

Listing 1 BASIC program to copy Sinclair character set into user RAM, using a machine code routine.

```
  10 FAST
  20 DIM C(512)
  30 FOR A=7680 TO 8191
  40 LET C(A-7679)=PEEK A
  50 NEXT A
  60 PRINT "SWITCH TO ""USER"" A
ND PRESS ""CONT"""
  70 STOP
  80 FOR A=7680 TO 8191
  90 POKE A,C(A-7679)
 100 NEXT A
```

Listing 2 BASIC program to copy Sinclair character set into user RAM.

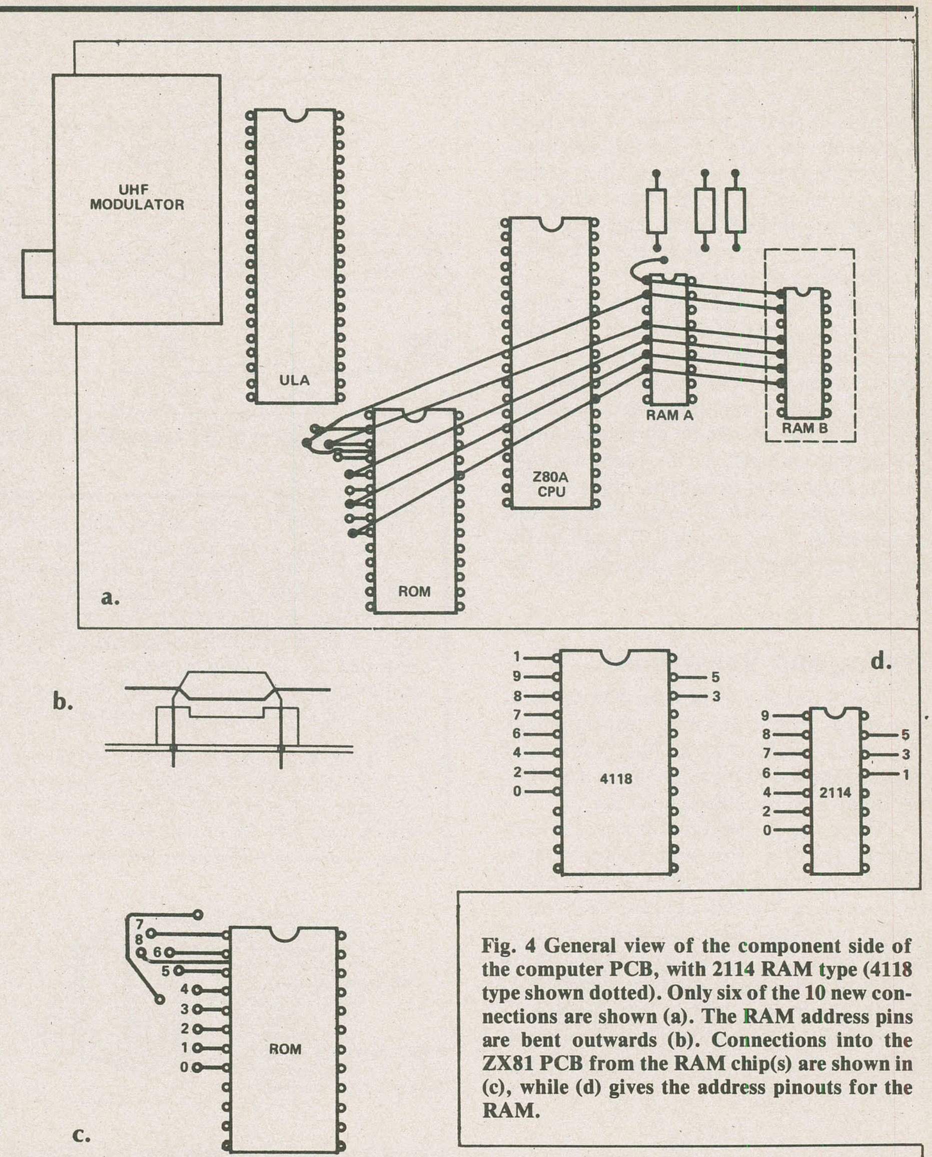


Fig. 4 General view of the component side of the computer PCB, with 2114 RAM type (4118 type shown dotted). Only six of the 10 new connections are shown (a). The RAM address pins are bent outwards (b). Connections into the ZX81 PCB from the RAM chip(s) are shown in (c), while (d) gives the address pinouts for the RAM.

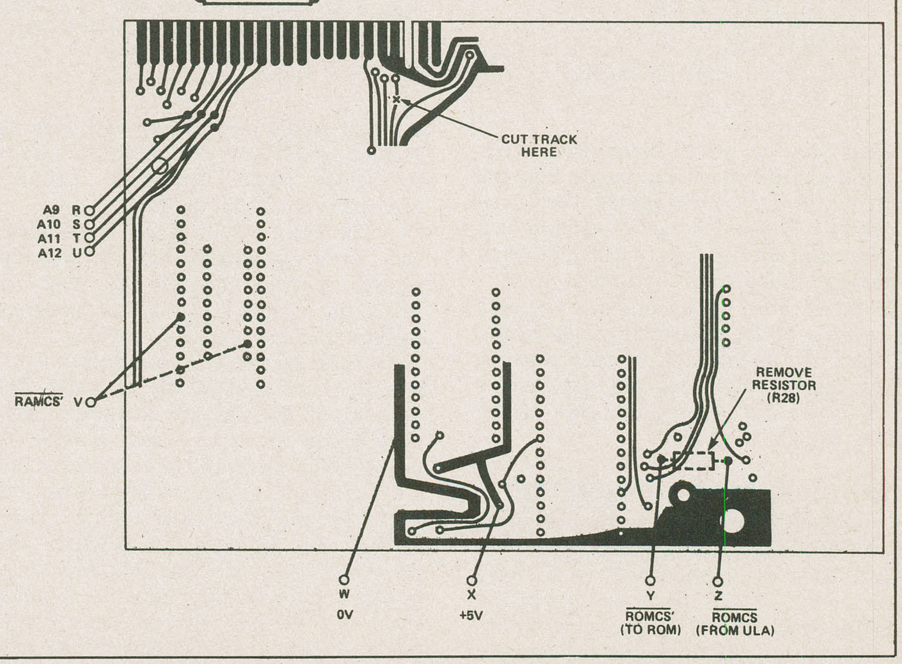
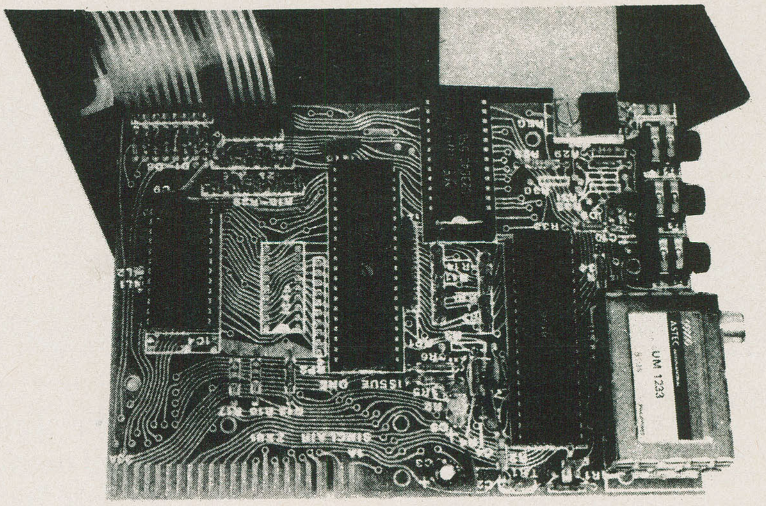


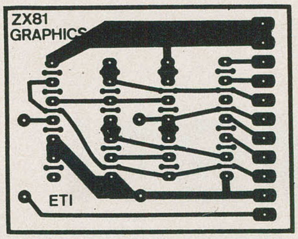
Fig 5 Connections to the underside of the ZX81 PCB. RAMCS' connections are shown for both the 2114 type (dotted) and the 4118 type (solid) RAM ICs.

Further Hardware Modifications

While this project was conceived as a very low-cost entry into user-definable graphics, several modifications could be made to bring a greater degree of sophistication to their operation. The manual switching could be replaced by software switching, for example: if you have an input/output port, this can be done by using one of the output port lines as the switch input for 1C1b.

Only half of the 1K memory is used and the A10 address line from the RAM chip could be switched between high and low instead of being fixed to a high, thus allowing two pages of user graphics to be available. Again, this could be a software switch controlled by an input/output port.






```
   1 REM 0000000000000000000000000
 00000000000000000000000000000000
 00000000000000000000000000000000
 00000000000000000000000000000000
 00000000000000000000000000000000
 0000000000000000
   5 LET AD=16580
  10 DIM A(8,8)
  20 FOR Y=1 TO 8
  30 PRINT "XXXXXXXX";Y
  40 NEXT Y
  50 PRINT "ABCDEFGH"
  60 PRINT AT 15,0;"INPUT PIXEL
COORD EG. A1 . HIT  NEWLINE TO F
INISH"
  70 INPUT A$
  80 IF A$="" THEN GOTO 160
  90 IF CODE A$(1)<CODE A$(2) TH
EN GOTO 70
 100 LET Y=CODE A$(2)-28
 110 LET X=CODE A$(1)-37
 120 IF X>8 OR X<1 OR Y>8 OR Y<1
 THEN GOTO 70
 130 LET A(X,Y)=ABS (A(X,Y)-1)
 140 PRINT AT Y-1,X-1;CHR$ (61+A
(X,Y)*67)
 150 GOTO 70
 160 CLS
 165 PRINT AT 15,0;"WHICH CHARAC
TER IS TO CHANGE?"
 170 INPUT A$
 180 LET CA=7680+8*CODE A$
 190 LET HB=INT (CA/256)
 200 LET LB=CA-256*HB
 210 POKE AD,LB
 220 POKE AD+1,HB
 230 LET AD=AD+2
 240 FOR Y=1 TO 8
 250 LET D=0
 260 FOR X=1 TO 8
 270 LET D=D+A(X,Y)*2**(8-X)
 280 NEXT X
 290 POKE AD,D
 300 LET AD=AD+1
 310 NEXT Y
 320 IF AD<16671 THEN GOTO 350
 330 PRINT AT 15,0;"YOU HAVE DEF
INED THE MAXIMUM OF 10 CHARACTER
S. IF YOU WISH TO DEFINE MORE CH
ARACTERS PLEASE SEE TEXT OF ARTI
CLE, OTHERWISE TYPE PRINT USR 16
360"
 340 STOP
 350 PRINT AT 15,0;"*****[illegible]
[illegible]*****TYPE Y OR N "
 360 INPUT A$
 370 IF A$(1)="Y" THEN PRINT USR
 16560
 380 CLS
 390 GOTO 10
```

Listing 3 Program for defining new characters and storing the information in the REM statement for later use (left): the values above are to be POKEd into the REM statement of line 1 using listing 4.

```
 500 PRINT "WHAT IS THE START AD
DRESS?       (NORMALLY 16514)"
 510 INPUT A
 515 CLS
 520 PRINT AT 0,0;"INPUT NEXT NO
. TO BE POKED. TYPE 999 TO TERMI
NATE"
 530 INPUT D
 540 IF D=999 THEN STOP
 550 IF D<0 OR D>255 THEN GOTO 5
30
 560 POKE A,D
 570 SCROLL
 580 PRINT AT 18,0;A,D
 590 LET A=A+1
 600 GOTO 520
```

ETI

ADDRESS					
16514	62	10	33	196	64
16519	17	186	64	229	213
16524	229	1	10	0	237
16529	176	42	186	64	209
16534	229	19	19	1	8
16539	0	237	176	209	225
16544	35	35	1	8	0
16549	237	175	225	1	10
16549	237	175	225	1	10
16554	0	9	61	200	24
16559	215	33	41	65	195
16564	3	4			

Book Review
ASTI

IF YOU WERE ambitious enough to build your own satellite earth station (ETI, July/Aug., '83), or if you've just installed a commercial unit, or if you sell commercial units, you've probably come across the problem that plagues everyone at some point: electrical interference with the video and/or audio. This interference is not surprising; the electromagnetic spectrum is full of all sorts of nasties just waiting to ride into your system on top of the tiny signal available from satellites.

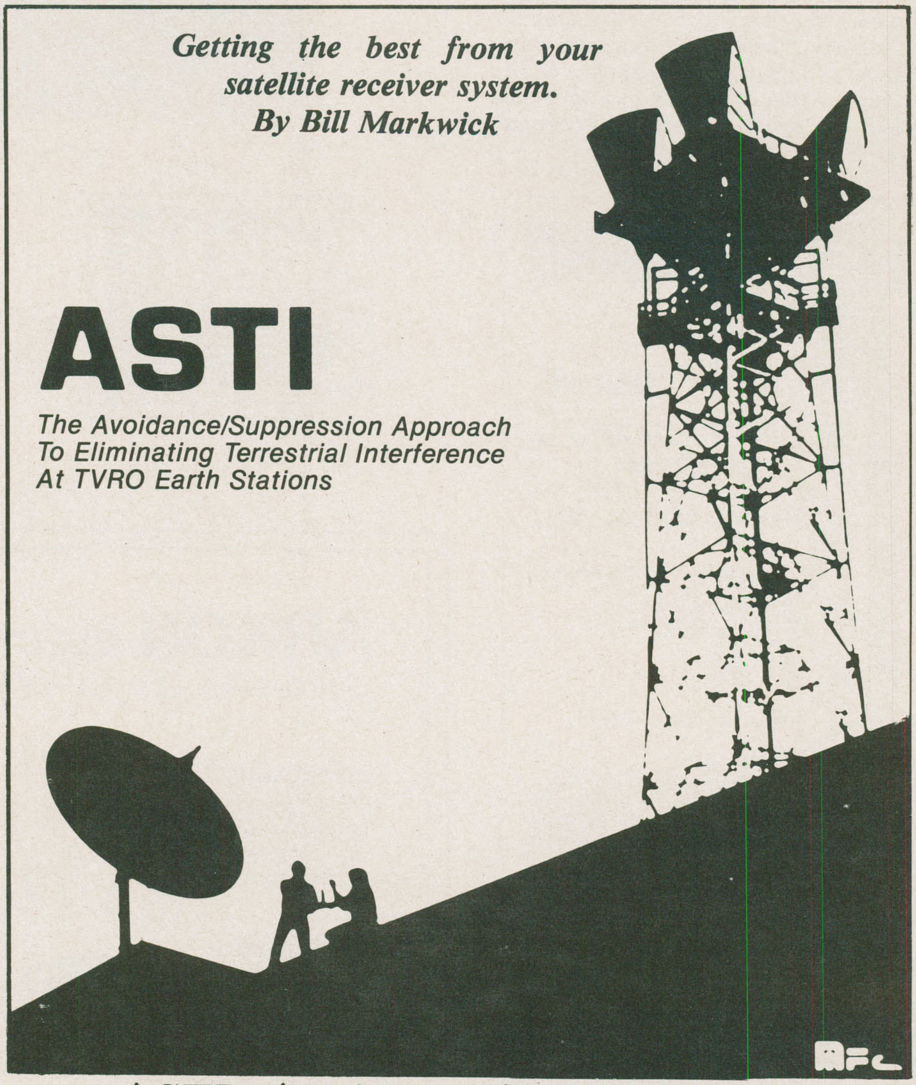
The next problem you have is one of information; where do you find reliable help for such a new technology?

Help
To your aid comes the Microwave Filter Company of Syracuse, N.Y. They've prepared a thick 3-ring binder describing the various causes and cures. Their interest in the matter is twofold: they would naturally like you to look into their comprehensive line of filters, and they also want to see filters used correctly. To this end, they've prepared this well-written, well-produced reference work.

System Planning
Interference can be minimized to begin with by carefully surveying the site; for instance, the dish can be located in the electrical "shadow" of metal structures to block interference and not the signal. Chapters One and Two give an insight into the basic workings of satellite microwave transmission and reception, with regard for proper siting of the antenna.

Station Basics
How can the miniscule signal from a satellite possibly be amplified enough to drive a receiver, and how do you find anything out by measurements? Chapter Three covers the simple calculations that can be used to determine power gain and noise figure. Formulae are included for the Low Noise Amplifier's performance, and for determining the various characteristics of the parabolic antenna.

Sources
Where does interference come from? After seeing the impressive listings in Chapter Four, you'll wonder how your signal ever gets through at all. Potential offenders are given along with their frequencies, and the electromagnetic bands are busy indeed. The need for more spectrum space means that commercial



ASTI: Avoidance/Suppression of Terrestrial Interference

The book is presently selling for $125 U.S., a considerable amount even if you compare it to other large technical tomes, but on the other hand, there doesn't seem to be any other book with so much TVRO information all in one place.

ASTI, and Microwave's TVRO products, can be obtained from Microwave Filter Company, Inc., 6743 Kinne St., East Syracuse, New York 13057 (315) 437-3953.

transmitters are now edging upward into the gigaHertz region, just where TV satellite broadcasts are found. There may also be some pickup of harmonics from radar and other systems.

Doing Something

Chapter Five has full-colour photos of the effects of various spurious signals on colour-TV reception; each photo gives the dB level of the offending interference. Chapter Six then goes into considerable detail on selecting the antenna; they're not all the same, and the efficiency of the dish/LNA determines the upper limit of the quality of signal. The electronics get a going-over; even the connecting cables can make a big difference.

Perhaps you feel that the siting measurement should be professionally done; expensive specialised equipment may be necessary, and considerable advice is given on what to check for in a survey.

You'll notice that we haven't even reached the section on filters yet; this should give some idea of the depth of the information given. The philosophy is that the installation should be optimised for reception, and filters added last, since filters inevitably remove some portion of the bandwidth. I mention this lest I've given the impression that the book serves as a catalog for the company's products; this isn't true in the least.

Filtering

Filters can be inserted at quite a few points in the chain; it all depends on the type and frequency of the interference. There are bandpass filters and traps designed for the feedhorn, just ahead of the LNA; they can also be placed after the amplification and ahead of the downconverter. There are 60 and 80 MHz traps to clean up the 70 MHz output of the downconverter; instructions are given on how to build your own tunable units. Colour photos show the remarkable improvement upon insertion.

Special Installations

If you install a system to feed more than one receiver, such as hotel or condominium TV, you'll appreciate the overview in the last chapters. Multiple-set hookups are naturally prone to spurious signal pickup due to the extra wiring involved, and there is a wealth of installation tips and explanations of filter actions. There's even a BASIC program for calculating the severity of interference based on sit measurements.

And Finally

The production of the binder is beautifully done, with heavyweight reinforced pages and dividers between chapters. The schematics and charts are first-rate, and ideas are presented clearly in a structured flow. It isn't a book for beginning electronics enthusiasts, however, and assumes that the reader has reasonable competence in working with RF.

ETI

Robotics

From squawking toys that stumble around the carpet to huge automotive welding machines, robots are almost as commonplace as the computer.

by Bill Markwick

THE SALESMAN AT the computer show had a large crowd around his booth to see and hear the voice recognition unit. He grandly waved his microphone like a talk-show host, and spoke into it: "What is eight minus two?" "Eight minus two," said the computer in an astoundingly lifelike voice, "is sixteen."

"Heh, heh," said the salesman as the crowd roared, "looks like a little software problem here."

That little incident seems to nicely sum up robots and the implied artificial intelligence that goes with them; they can be absolutely amazing in a variety of tasks, but it doesn't take much to trip them up into a display of equally amazing stupidity. We're still a long way from the Hollywood view of robotics.

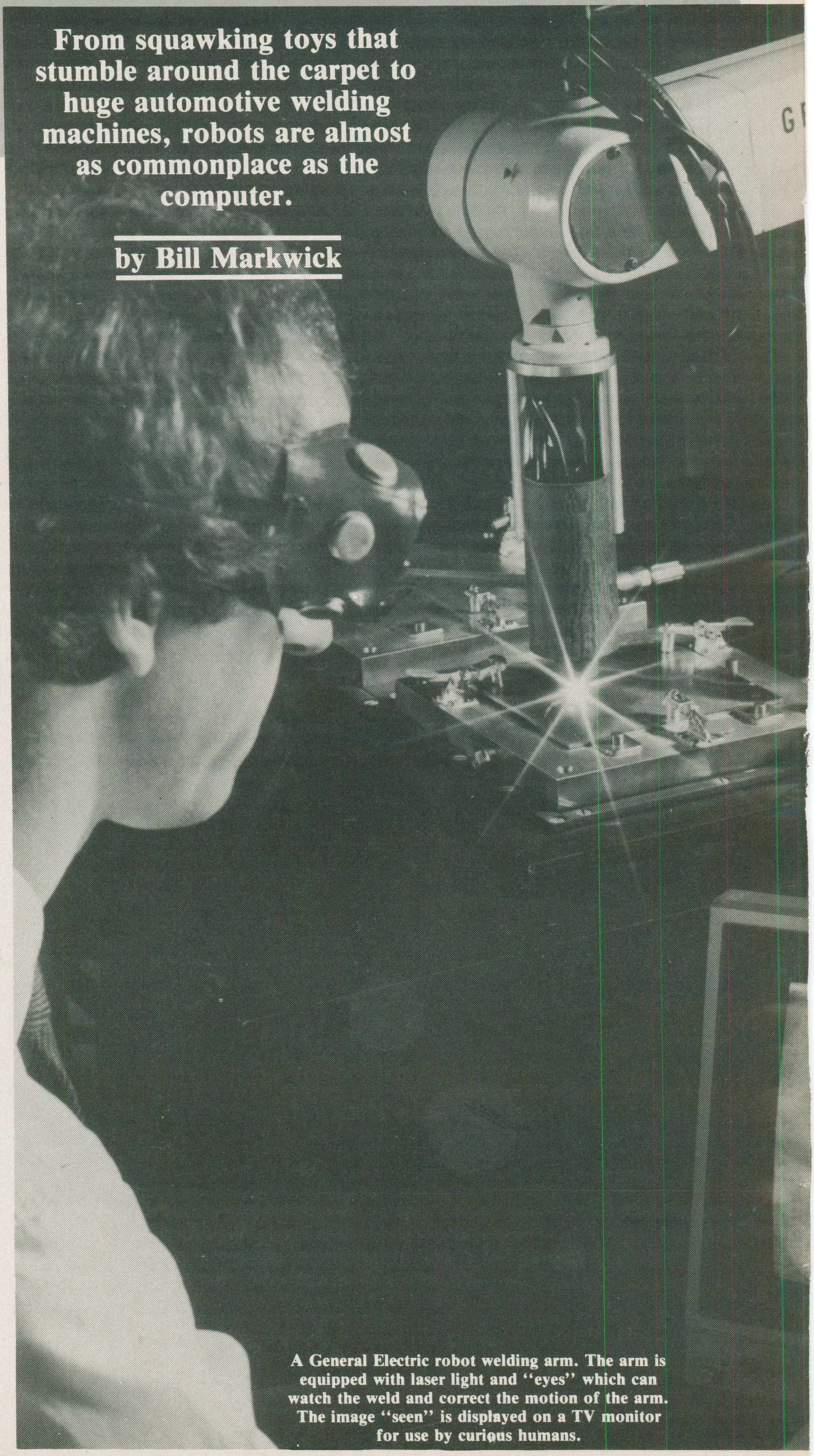
Hollywood

Robots in their cinematic incarnation are such natural scenestealers that science-fiction movies are full of them. For dramatic reasons, they tend to be humanoid in actions and appearance, and if possible, loveable. The Star Wars robots come to mind; even R2D2, who wasn't people-shaped, was as cute as all get out. In the interest of screen appeal, script writers have ignored practical limitations to making a machine perform human functions; audiences have seen so many motorized tin people that the image is firmly fixed; however, it's a long way from the reality of "intelligent" machines. And that brings up a good question: if mechanical humanoids are impractical at present, then just what is a robot?

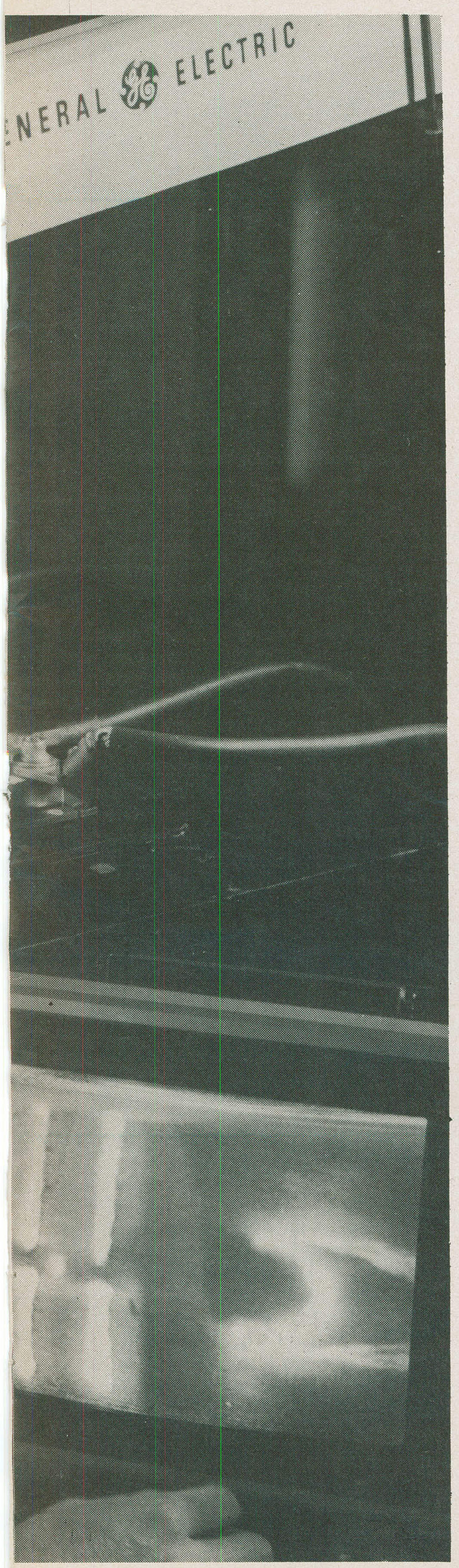
The Blurred Definition

What would the difference be between, say, a microcomputer and a robot? Well, you might say that the robot has mechanical motion, that it's self-contained and can move around the room and pick things up. But what if the micro has voice recognition and can answer a person? If we say that a robot is a machine that can perform tasks normally done by humans, what of the material-cutting robots that just look like a bandsaw? There's a bomb-disposal robot made in Ontario that looks like a go-cart with a TV camera on it; is there a category for that one?

It's probably safe to go by intuition at this point; you can call just about any machine a robot and get away with it. We're really more concerned with the



A General Electric robot welding arm. The arm is equipped with laser light and "eyes" which can watch the weld and correct the motion of the arm. The image "seen" is displayed on a TV monitor for use by curious humans.



strengths and weaknesses of machine intelligence; you can make a blanket statement and say that if a machine can be taught to do a reasonably complex task and perform it without human guidance, it's a robot. Of course, a programmable washing machine might then be called a robot. That's the trouble with pigeonhole definitions.

The Housebroken Robot

This year saw the unveiling of several makes of home robots from companies such as Heath, RB Robots, and Androbot. To keep the cost to a reasonable sum, most home robots have that oildrum R2D2 look, running on little wheels and slowly waving little arms under control of a microprocessor.

It's interesting that the manufacturers have invested millions in developing and building these little units without any real idea what they're good for. At the Heath press conference for the Canadian release of the Hero 1, reporters watched it trundle around the carpet and listened to it blare out with its gargley that-does-not-compute voice, and then asked, reasonably, "But what's it for?" The company officials replied that they sort of didn't know, that home computers were left up to the hobbyist's ingenuity at first, that uses would be found. It's programmable. You can make it do just about anything.

At the end of the conference people filed past a reporter who was doggedly trying to make it pick up a plastic tumbler; it kept knocking it over.

RB Robots, makers of the RB5X, are a little more aggressive in their marketing. Press releases published in magazines and newspapers have led the public to believe that RB5X can fetch a beer, vacuum the carpet, and put out fires. Indeed it can; the questionable point is just how well it can do any of these things. To get you a beer, it requires a special refrigerator to allow for the limitations of its guidance and arm systems; none of the home robots have sensors sophisticated enough to open a regular refrigerator, much less find a specific item inside. Their "vision", which is usually infrared or ultrasonic ranging, is limited to there-or-not-there general detection. The vacuuming is accomplished with a battery-powered add-on; the vision and/or a programmed course lets it steer around a room without bumping into much. However, since 6-amp domestic vacuums often leave something to be desired, it's doubtful if the tiny toy can pick up much dirt. It also won't reach under chairs.

As far as fire extinguishing goes, the heat sensors in the robot are connected to an external system, such as water sprinklers or CO2 nozzles. Perhaps it's better than trusting to a simple smoke detector, or no detector at all.

The main point is that they're toys; fascinating ones, but toys nonetheless. Their efficient microprocessors may mean that they can easily be programmed to do 1000 separate steps with only 4K of on-board memory, making them ideal teaching aids for learning industrial robotics, but their general uses are limited. A spokesman for Androbot was quoted as saying that robots can get the paper, pick up after you, and put loose shoes in the closet. They simply won't. They aren't smart enough. The home robots can certainly be programmed (labouriously) to pick up a certain shoe and put it in a certain closet, but let loose in a room without painstaking guidance, they're just as likely to pick up the cat and stuff it under the sink.

Smartening Them Up

Since we're largely unaware of the immense complexity of our own brain's functioning, we tend to think that recognizing and picking up a specific object is an extremely simple thing to do. Infants can do it, so it should be a piece of cake for a microprocessor, especially since micros and their memories are now becoming smaller, cheaper and more sophisticated.

In fact, recognizing an object and picking it up is a phenomenally complicated procedure. It involves requirements of vision, touch and memory far exceeding any but the most expensive industrial machines, and even then the function is still a bit primitive.

It's possible for a home robot to connect to a home computer via cable or radio, and it might be tempting to imagine their capabilities expanded by adding several megabytes of memory and multiple microprocessors. However, you would also have to add an upgraded vision system with higher resolution and better ranging, fairly comprehensive touch sensors, and more complicated motorizing of the arm or arms. Controlling all these would require a tremendous amount of memory, and the high cost of the mechanical parts would mean that you would be approaching the level of expensive industrial robots.

They Sell Anyway

In case you think the above is a bit harsh on the little domestics and their salesmen, there's no getting away from the fact that they probably have the appeal of the ultimate gadget. Those who are lovers of gadgets, and this seems to be the majority of us, will be overjoyed to know that you can hook up some of the robots to microcomputers such as the Apple; this expands their capabilities to include such things as voice recognition and more elaborate movement control.

Of course they can't do anything useful, and they work in a cumbersome stupid sort of way. But they're *fun,* man!

If we leave the fans of the little domestics programming them to greet callers at the door with peculiar messages, we arrive at robots which were designed from the start to be as useful as possible.

Industrials

Worker robots just had to happen. Once motor control signals could be stored one way or the other, experimenters naturally tried to make creations that would do tasks of some sort; in fact, the word "robot" comes from a Slavic root meaning "forced labour". The gadget fans just wanted to see the things go; the entrepreneurs' eyes glimmered with the concept of an employee that wouldn't need coffee breaks or parking lots.

Early robots were a long way from the present models; the first applications of servo-control would probably have been punched tapes running factory machines which did complex but repetitive tasks. They wouldn't have looked like our concept of robots at all; just motors and solenoids mounted on a lathe or drill press. However, it wasn't long until microprocessors met with improved servo-motor manufacturing, and robotics emerged from dedicated one-job applications to more versatile units which could be "taught" to do a variety of tasks.

According to the Matsushita robot company, there are definite categories of industrial robots. These are:

1. Manual Manipulator. These are the noted "Waldoes" of science-fiction fame. They consist of a set of arms which duplicate the movements of a human controller; they're really a power assist for the person, and are used to isolate the operator from a hazardous procedure.
2. Variable sequence. This is a manipulator operating from preset instructions that can be easily changed.
3. Playback Robot. These learn an operation by memorising the sequences performed by a human demonstrator. For instance, the person could move a paint-spray arm along a certain path on a car body; the robot would then reproduce this on the assembly line.
4. Intelligent Robots. Despite the contentious word "intelligence", these robots have enough processing power and external sensors to make decisions based on the facts they are capable of recognizing.

Unmanned Factories?

There's no doubt that robots are everywhere in industry; the first cases have been reported in both the US and Japan where maintenance workers have been killed while servicing large assembly line robots. This naturally brings to mind the movie scenario of robots running berserk and smashing their way down the street. In fact, the accidents were caused by the absence of proper safety interlocks which would have disabled the machines during servicing; it could have happened with any large industrial machine.

In any case, robots are a familiar part of any large factory, and will become more so as the technology improves. The usual description of a robot employee reads: works 24 hours a day without coffee breaks; repeats its tasks tirelessly; works in hazardous areas; works for about one-third the cost of a person; doesn't ask for any sort of fringe benefits, and never goes on strike. All this is true. However, Mr. H.A. Poling, executive Vice-President of the Ford Motor Company, said in a speech to a robotics conference in 1982: "But there are other things that robots won't do. They never laugh at a joke, or say good morning. They never give a pat on the back, or remember a birthday. They don't buy cars, and they don't vote in favour of new labour agreements."

This is an interesting point on the "humanity" of robots; they just don't have any. On the positive side, they take over boring or distasteful or dangerous jobs. This raises the question of what to do with the employee who's been displaced. The robotics industry hurries to point out that robots create more jobs than they eliminate: the increased production results in more sales; more servicing, and more support staff. Mr. Poling points out that Ford has never laid off anyone as a result of robots, saying "if a job has disappeared, we have retrained or upgraded."

Again, all this may be true, but the image of a country with total automation and people-less factories brings to mind the anonymous quotation "They earned a precarious living taking in one another's washings."

Artificial Intelligence

Just how intelligent are robots right now? It's safe to say that they're pretty dumb: smarter than your dishwasher, but well below your pet gerbil. Of course all this will change, because integrated circuit manufacturers usually have chips on the lab table that are far ahead of anything released commercially; it shouldn't be long until the next generation of microcircuits is unveiled for your amazement and delight. Both American and Japanese firms are hard at work on two functions which will vastly increase the capabilities of industrial robots; vision and speech recognition.

A company in Windsor, Ontario, called Diffracto, Limited is making vision systems for robots, and claims to be far ahead of industry competitors. At the moment, optical sensing devices used with lasers or other light sources can perform such jobs as sorting bolts, gauging the size of extruded wire, and checking for flaws in surfaces, but this is pretty basic stuff. On the drawing boards are more sophisticated devices that will recognize objects and sort them according to quality, a natural for the canning industry.

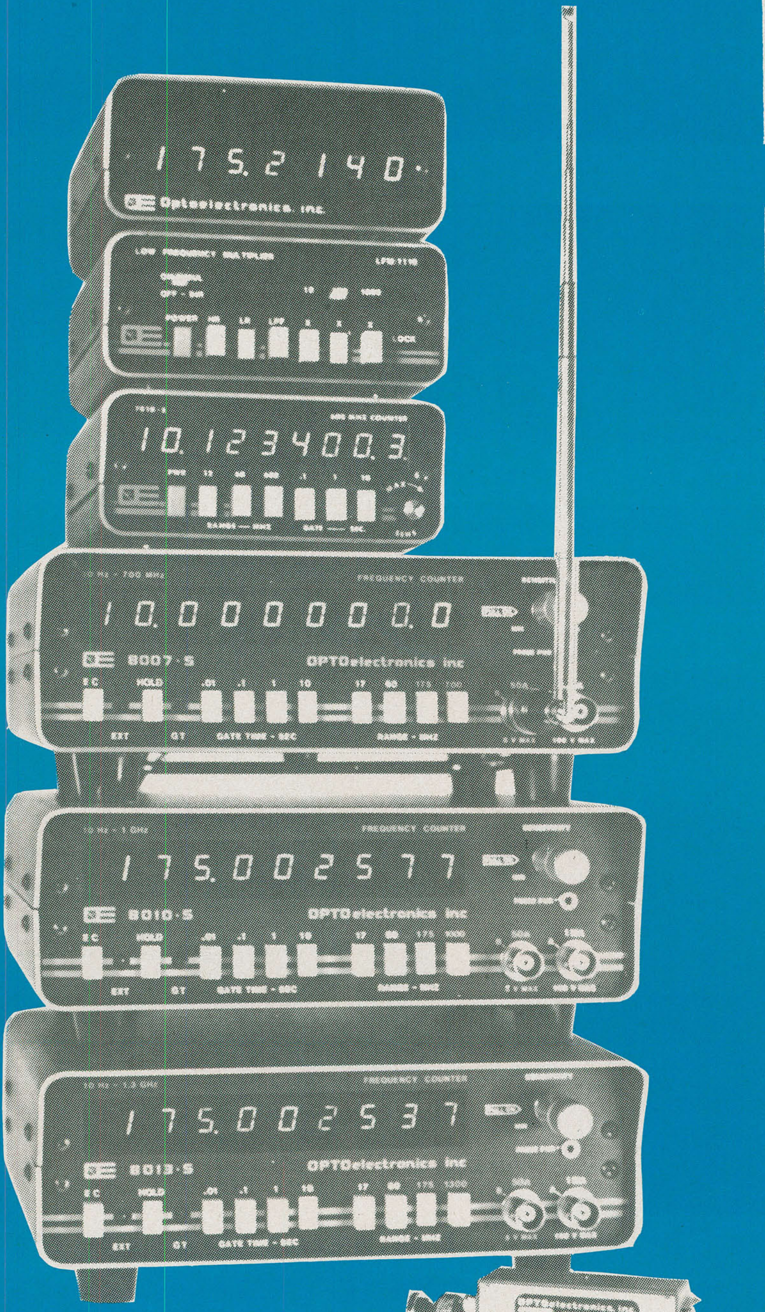
General Electric has developed a simple laser vision system for guiding welding units; it can continually observe the joint and weld "puddle" and make adjustments as it moves. This again is fairly simple, but it points the way to the vision systems we can expect in the near future. There is no reason that a robot cannot scan an entire room with a television lens, recognizing objects by comparing them with previously stored information, and making decisions based on its program. There are already security systems which use this method; at present they are limited to simple intruder detection (it simply detects any change in the scene - it's only suitable for empty rooms) but the only limitation here is processing power. As computer systems get cheaper, there is no technical reason why robots couldn't have vision as good as a human's; the choices and decisions it makes with that visual input is quite another story.

This is where artifical intelligence comes in. It's an elaboration on the more familiar computer programs, because the robot's computer will have a huge volume of sensory inputs once vision and touch systems become more elaborate. The sense of touch, at the moment, is usually provided by a series of microswitches which tell the controller whether or not an object has been successfully grasped, but soon more refined methods such as conductive touchpads will allow better discrimination; even subtle differences in surface textures could be easily detected. With so much information coming in, the computer needs to be able to do better than the familiar "if-then-else" logic states; it needs to be able to make decisions which appear human for all intents and purposes. A "thought" process in a robot's computer might go something like this: "I have inserted 3,458 bolts, but this next one feels 1.5 millimeters too short. The others I have are the wrong colour. There is no answer from the inventory robot. The production-control robot says I can't stop the line. A human is approaching. It's Bob. He'll know what to do. I'll ask him."

This is somewhat beyond the capability of a ZX81, even with the 64K RAM pack. The robot has made a simple decision based on the yes-no aspects of the parts supply, but has had to recognize a person and work out that the person could solve the problem. A robot that works tirelessly is one thing: robots that can fix unforeseen problems would be a production manager's dream.

OPTOELECTRONICS, INC.

BCS ELECTRONICS LIMITED



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Mr. Asimov

In the science-fiction classic, *I, Robot,* Isaac Asimov took a wild guess at the future state of robotics and came up with mechanical men located in the 21st century. It's interesting to note that he was quoted in the press recently as saying that he didn't think he would live long enough to see the robotics industry as it is today. This shows rather well the dangers of the crystal ball applied to technology; he was right about the coming ultra-sophistication of robots. Only the timing was wrong. On the other hand, he also formulated the Laws of Robotics: a robot shall not harm a human, a robot shall obey its orders and so on. This is where a naive belief in the reliability of machinery got in the way. Murphy's Law overrules Asimov's laws: even the smartest of artificial intelligences is subject to the whim of wiring errors and malfunctioning microchips, and may, with the very best of intentions, grab you firmly with its waldoes and twist off your head under the impression that you're a rear bumper for an '85 Toyota. People with defective wiring do this sort of thing all the time; it's in the papers.

Robots will be dangerous, but so are cars and airplanes and sharp pointed objects.

Forecasting

If Isaac Asimov can't predict the timing of robotics, it might be a good idea to pass over the whole idea. Fortunately, other people have gone out on a limb for us. Dr. Archie Bowen, Professor of Systems and Computer Engineering at Ottawa's Carleton University, was quoted in the Ontario government's **Technology News** as saying that since the capabilities of silicon chips seem to double every 18 months or less, we can expect speech recognition by the middle of the decade and real artificial intelligence by the middle of the next. The speech recognition will soon progress from simple word commands to understanding sentences and sorting out meanings according to context. The voice-operated typewriter will be a reality. He goes on to say that home robots will be the cat's pajamas by the end of the century, and no home will be complete without one; it all depends on breakthroughs in low-cost artificial intelligence, a breakthrough that is being taken for granted (we also need a breakthrough in low-cost indexing motors and pulleys and solenoids, but maybe we can get a robot to make these for us).

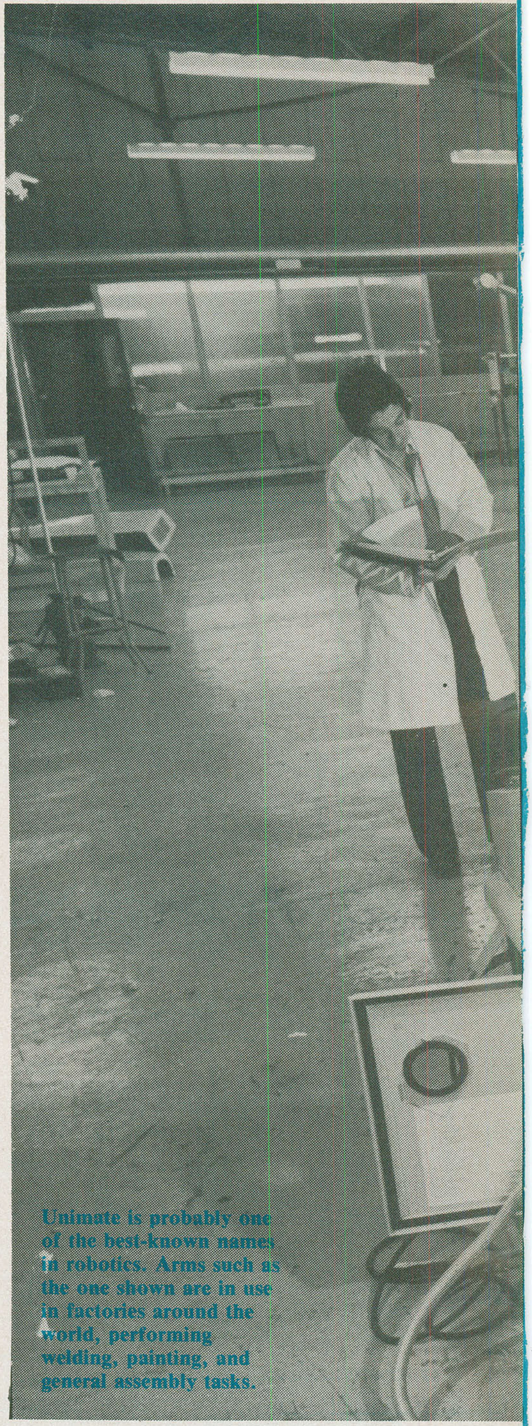
Professor Bowen then says "When you get into a dialogue with a machine, it shakes your belief in your position on the planet." This seems to say a lot about Professor Bowen. The invention of the scientific calculator had everybody ga-ga, but soon it became just one more item to prop up next to the food processor that you didn't use as much as you thought you would.

But this is frivolity. The real point comes when he says that artificial intelligence will result in an equalization of our intelligence and capabilities: "the greatest contribution to maintaining our social structure will be from those who can live creatively with our machines."

Hopefully those who can live creatively with the New Machinery will arrange for a bit of input from those who can't. Society doesn't reject people who can't drive, for instance.

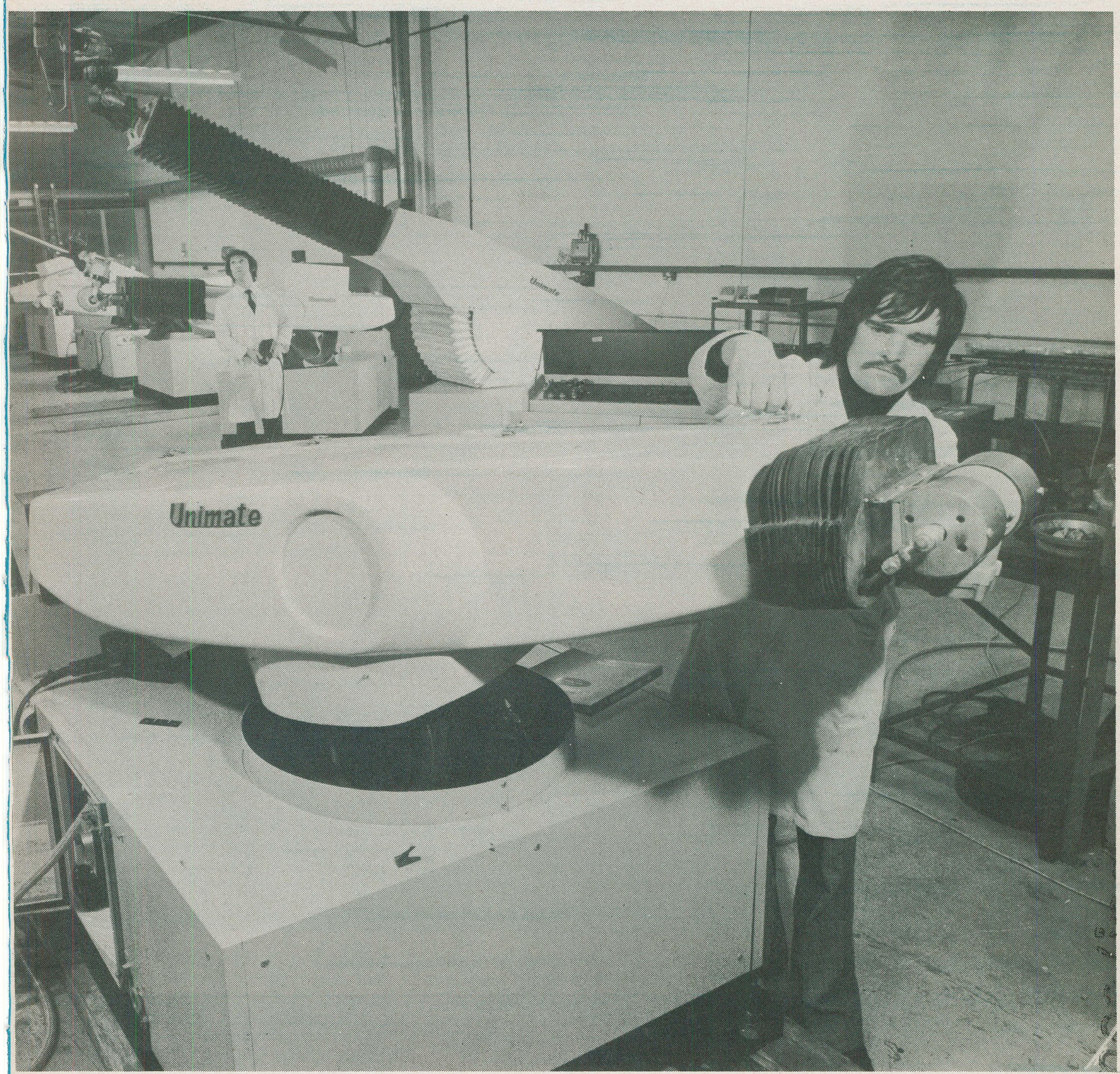
Safe Forecasting

It would be foolhardy to make a definite statement about such spooky things as the use of microsurgery to implant a human brain into a robot to produce science-fiction's "androids". On the other hand, some things are self-evident. One of them would be the use of robots by small businesses as well as heavy industry. The Japan External Trade Organization said in their journal **Industrial Robots,** ". . . robots will be used more and more by smaller businesses . . . robots are getting cheaper and skilled workers are getting more expensive and harder to find, making robots an attractive alternative even to tiny cottage-type industries." Mind you, if robots will be displacing so many skilled workers, employees shouldn't be hard to find. In any case, this swing to robotics is



Unimate is probably one of the best-known names in robotics. Arms such as the one shown are in use in factories around the world, performing welding, painting, and general assembly tasks.

The Rumble equipment company of Rexdale, Ontario, produces welding packages using Hitachi robots. The robots are "taught" to weld complex shapes by using an external keyboard.



a natural extension of the changeover to automated machinery of all types.

Another safe guess is that labour unions will not vehemently oppose the introduction of robots. Basil Hargrove of the United Auto Workers was quoted in Canada's **Business Life** as saying "(robotics is) desirable because we have to remain competitive in a worldwide market."

Companies will have to rethink their entire manufacturing procedure before buying robots simply because they work longer for less; otherwise the robots will not be integrated into the flow of the production line. They may end up shelved in a back room somewhere.

There is general agreement from both industry and manufacturers that more and more robots will be employed despite the threat of displacing workers, because more jobs will be lost if robots aren't used. The Ontario government has spotted this trend, and has opened two special centres for guiding manufacturers; one is the Robotics Centre in Peterborough, the other is the Computer Assisted Design/Computer Assisted Manufacturing (CAD/CAM) Centre in Cambridge.

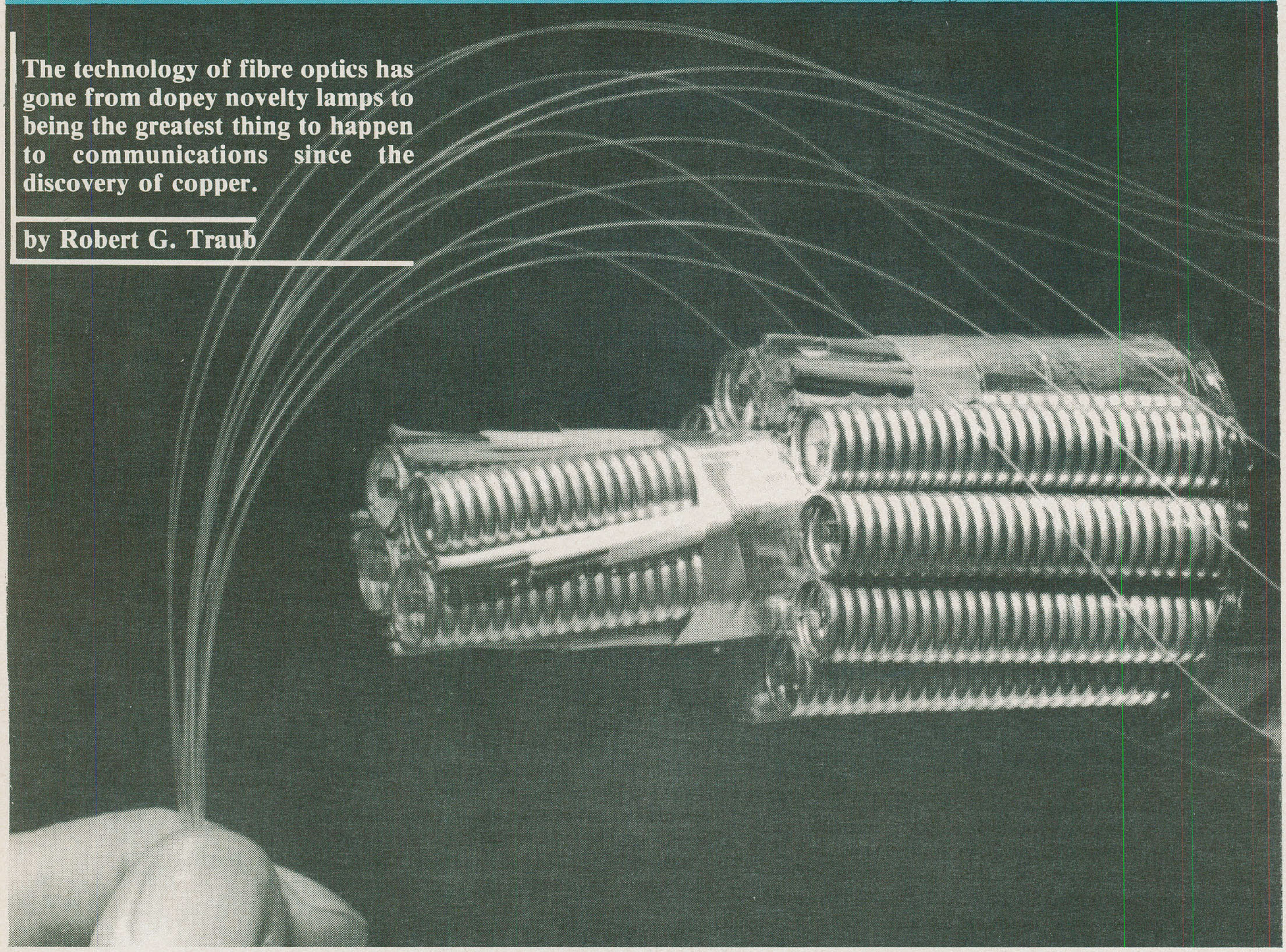
Universities will begin offering degree courses in Robotics (Robotics 101: The Laws of Robotics, Professor Asimov). This has started already; the Cranfield Institute of Technology in the UK is now offering a Master's Degree in robot science.

At this point, the home robots are little better than toys, and the large industrial types are hidden away in factories. All this is soon bound to change; remember that the same conditions applied to the microcomputer a very short time ago. ETI

Introduction to Fibre Optics

The technology of fibre optics has gone from dopey novelty lamps to being the greatest thing to happen to communications since the discovery of copper.

by Robert G. Traub



THE FIELD OF land line telecommunications represents one of the fastest changing, and rapidly developing, high technology areas. The introduction of the integrated circuit, and later, the microcomputer, have enabled faster, more efficient information and data exchange between telephone subscribers. Even so, the land line telecommunications field still has some serious drawbacks. One of the major drawbacks is represented by the speed restriction inherent in the system, through the use of copper wire cable. These cables restrict the bandwidth and thus the data rate at which information can be transmitted from one point to another. As well, the copper wire system is prone to static noise interference and crosstalk, while presenting a lack of security and a shock hazard. To overcome these and other limitations inherent in the copper wire cable systems, many of the world's telephone companies, such as Saskatchewan Telecommunications and Northern Telecom Canada Ltd., are currently involved in the development of fibre optic cable systems.

The Basic Idea

Fibre optic principles and theories have been understood by scientists since before the turn of the century. Experiments were carried out and demonstrated in Britain in 1870 by John Tydall, a noted physicist of the times. However, until recently the technology to develop the required hardware for their use was not available. Remarkably, in the past few years, many different technical advances occurred at about the same time, thereby making the development of systems and networks possible. Necessary components, such as high quality, low attenuation fibres, efficient light emitters, and high speed light detectors, all with a high degree of compatability, have been developed. Other important developments include reliable splicing devices, and high quality, low loss connectors. Connectors have been developed for both simplex and full duplex systems, along with a series of sophisticated network connectors used to route the light beam from a single fibre to two or more fibres.

Employing fibre optic systems for the transmission of data has shown a number of advantages over the present method of wire cables. First, optical fibres, because they transmit light and not electricity, offer complete electrical isolation between circuits, thereby eliminating hazardous electrical ground loops. Further, the fibres do not present a shock or fire

hazard, allowing them to be used in areas where highly volatile liquids and gases must be processed. This also points out the fact that there is no possibility of a short circuit anywhere in the fibre optic system. Optic fibres are immune to radio frequency interference and other electromagnetic effects. This results in complete isolation from transient voltages (noise), and surges of harmful high current levels induced by lightning. The fibres are smaller in diameter than the equivalent circuit carrying copper wire, and many more fibres can be placed in a cable, offering even more circuits with a lower total weight. Unlike their copper counterparts, fibre optics are not subject to 'crosstalk' from adjacent fibres, and are free from signal leakage. These two points show the additional security available in the fibre optic, since they cannot be tapped by induction devices as can copper wire.

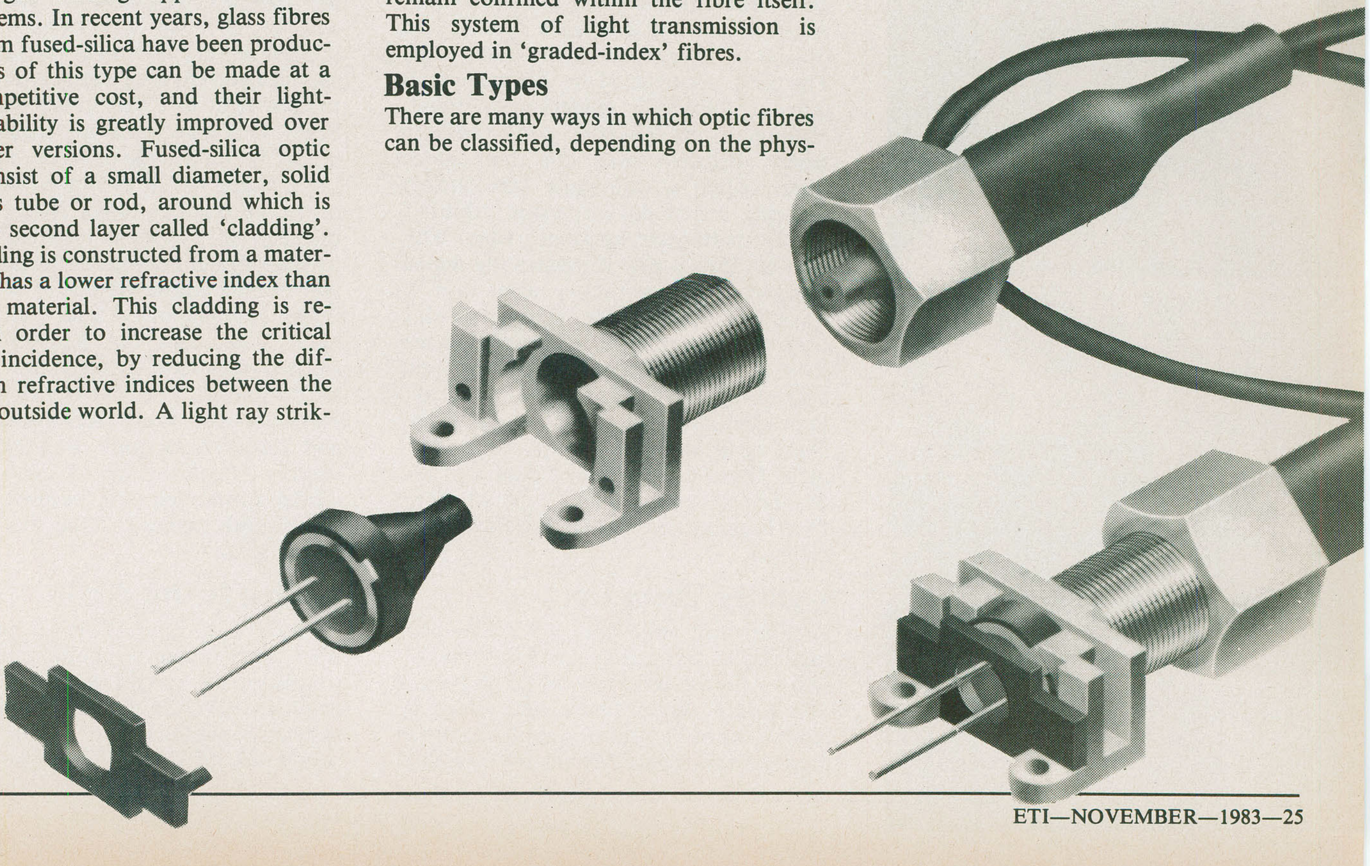
Putting Them To Work

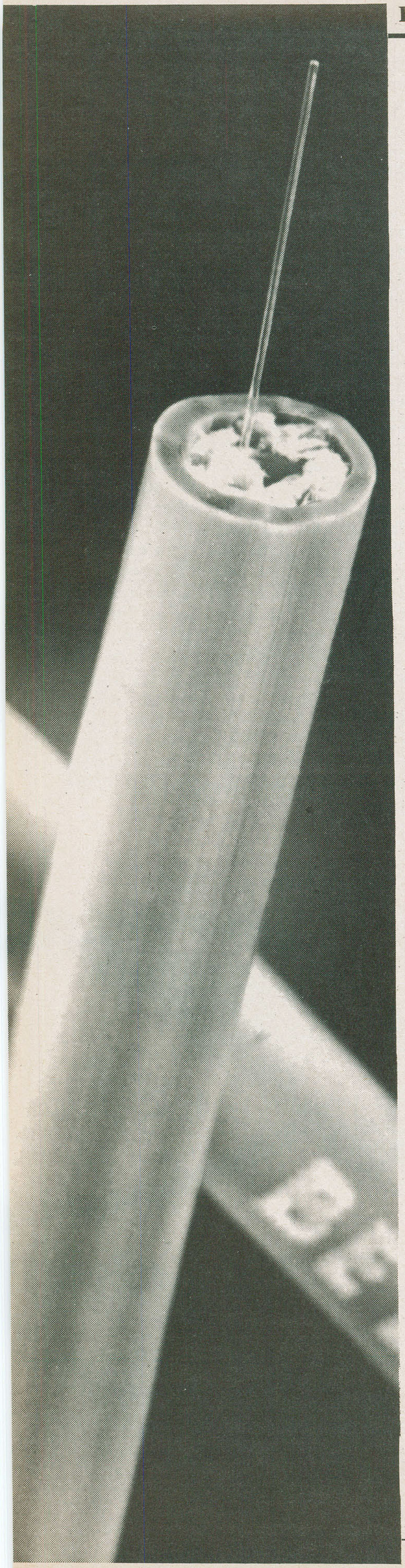
It was not until the 1950s that an optical quality glass fibre was developed. The glass fibres of this era were very expensive to produce, and exhibited a very high attenuation factor. These facts prevented them from finding acceptance for commercial use, as the copper wire being used at that time was easier to work with and much less expensive. About a decade later, in the early 1960s, an economical plastic optic fibre was produced. This type of optical fibre did find its way into commercial use. However, they were restricted to less technical areas such as ornaments, remote light sensing applications and novelty items. In recent years, glass fibres made from fused-silica have been produced. Fibres of this type can be made at a very competitive cost, and their light-carrying ability is greatly improved over the earlier versions. Fused-silica optic fibres consist of a small diameter, solid core glass tube or rod, around which is bonded a second layer called 'cladding'. The cladding is constructed from a material which has a lower refractive index than the core material. This cladding is required in order to increase the critical angle of incidence, by reducing the difference in refractive indices between the core and outside world. A light ray striking the glass wall at less than the critical angle of incidence will be refracted into the air and lost. If it should strike at an angle greater than the critical, it will be totally reflected back into the rod. The critical angle depends on the refractive index of the two materials; the glass rod and air, or the glass rod and cladding. In high quality optical fibres, the cladding is made of glass, while in lower quality fibre, the cladding is made of plastic. The cladding, in either case, is very thin, and the actual physical bond between it and the glass core cannot be seen. In all cases, light from a source will propagate in the optical fibre only if it is either confined within the glass tube (called total internal reflection), or by refracting the light through many layers of glass of different densities, each having a refractive index less than the preceding layer, with the layer of highest refractive index at the centre. This second method is called 'continuous refraction.'

In the case of total internal reflection, the light must enter the glass fibre at an angle equal to, or greater than, the critical angle of incidence. At angles less than this, the light will strike the glass surface and be refracted into the air and lost. At angles equal to, or greater than, the critical angle of incidence, the light will strike the internal wall of the fibre and be reflected back along the length of the fibre. This is the common method of light transmission used in 'step-index' fibres. In the case of continuous refraction, the light entering the fibre will gradually be bent as it passes through the many layers of different refractive index changes, and will remain confined within the fibre itself. This system of light transmission is employed in 'graded-index' fibres.

Basic Types

There are many ways in which optic fibres can be classified, depending on the physical properties involved. However, in relation to the way in which they propagate light, there are three main categories. These are known as multimode step-index, monomode step-index, and multimode graded-index. The 'mode' is related to the way in which light rays, which enter the fibre at different angles, are propagated. In the case of the multimode step-index fibre, a light ray entering the fibre and striking the interior wall at a high angle of incidence will be reflected fewer times than a light ray which enters the fibre at the same time, but strikes the interior wall at a lower angle. Due to this fact, the ray of light striking the interior wall at a high angle will travel along the fibre at a faster rate as a result of the reduced number of reflections. In fact, a light ray that enters the fibre parallel with the fibre's axis (called the 'axial ray'), would not be reflected off the walls of the fibre at all (assuming no bend in the fibre), and have the shortest path; therefore it would reach the far end first. Each light ray of different angle is called a 'mode', and the difference in time required by each ray to reach the far end is called 'modal dispersion'. This dispersion does not effect the light gathering properties of the fibre, but it drastically affects the rate at which a pulse of light can be transmitted. For instance, a very short pulse will have all of its light rays entering the fibre at the same time, but at different angles.





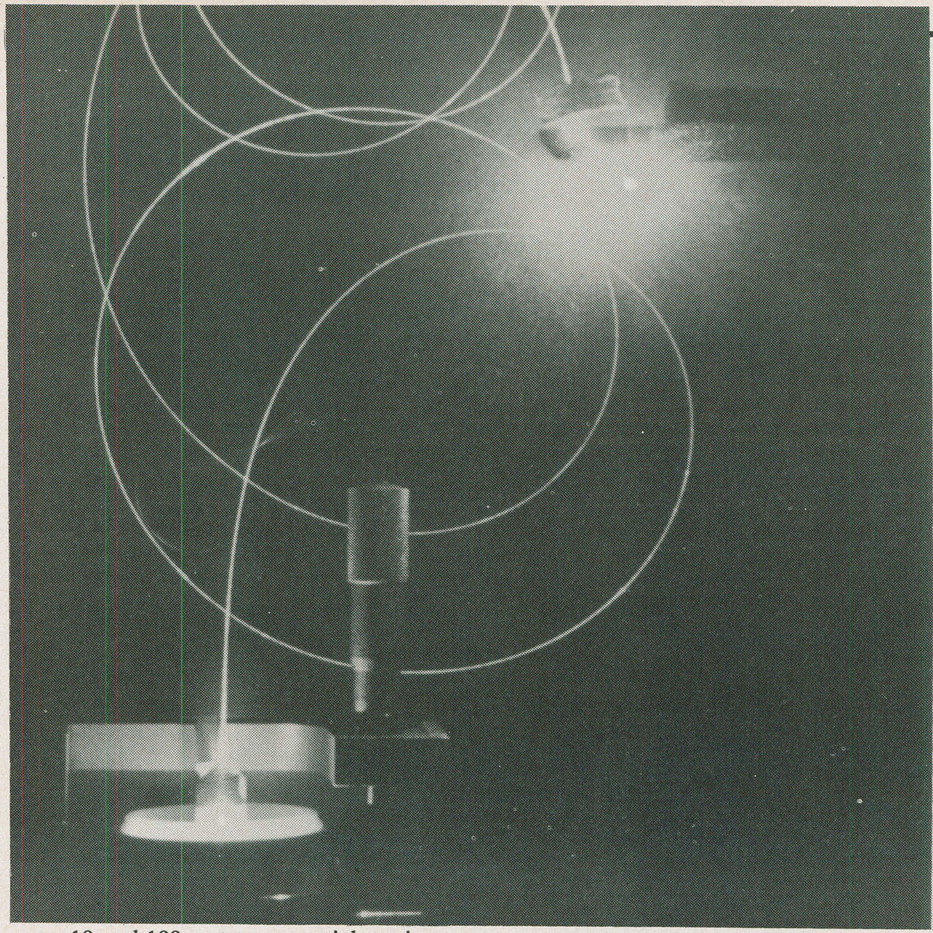
This action will result in one of the rays reaching the far end ahead of another (with the axial ray being first), and so on, until all the rays of different angles have arrived. This will result in the sharp pulse sent being spread out over a period of time, and thus badly distorted. The long pulse received at the far end will no longer represent the fast, short pulse originally sent. Multimode step-index fibre of this type is the least expensive of all the optical fibres. It is also the easiest to work with due to its rather large diameter and good light-gathering properites, but has very bad modal dispersion characteristics. One way to combat the modal dispersion of the thousands of light waves that travel down the length of the fibre is to make the fibre as small in diameter as possible. This method is used in what are termed 'monomode step-index fibres'. Monomode step-index fibre was designed to minimize the number of different angles that the light could enter the fibre originally. As a result, this type of fibre is extremely thin, expensive, and very hard to work with. However, it offers the least amount of modal dispersion by allowing only a single (mono) mode to propagate efficiently. This requires special contruction techniques where the cladding is of a refractive index only slightly less than that of the core. The cladding is then increased in diameter in order to allow the extremely thin fibre to be handled. Monomode step-index fibres are very efficient, and can be used at high data rates over long distances. Another method employed to reduce modal dispersion is by having a glass fibre which exhibits a higher density at the center and gradually decreases in density as it approaches the outer edge. The fibre constructed in this manner is called 'multimode graded-index fibre'. Multimode graded-index fibres offer a larger diameter than the monomode fibres, while at the same time greatly reducing the modal dispersion exhibited by the multimode step-index fibre. This type of fibre is able to reduce the modal dispersion by forcing the axial rays to travel in a dense centre material, slowing them down, while the reflected rays are constantly being refracted by different densities, and actually travel at about the same rate due to the time spent in the less dense outer material. Multimode graded-index fibres offer excellent data rate and distance properties. This type of optic fibre is used extensively in cable television systems.

Lighting Them Up

Each of these optic fibre types requires a small light source using a narrow band of frequencies in order to reduce propagation losses. An ordinary light emitting diode cannot be used for anything other than short transmissions of a few feet, and at slow pulse or data rates. Ordinary LEDs disperse light in all directions, and are much larger than the fibre itself, which introduces severe power coupling loss. For these and other reasons, ordinary LEDs are not an efficient light source for use with optic fibres. To overcome the difficulties displayed by the common light emitting diodes, research was undertaken in recent years to provide new and better types. Due to this concentrated research, a number of special light emitting diodes have been successfully developed. One such diode, a planar heterojunction device, is constructed using many layers of n and p material to form an "nnppnp" light emitting diode. This, in turn, is covered with a small metal plate, with a tiny hole at the centre to allow the light to shine through. This type of construction offers a very brilliant light spot concentrated in a very small area in such a manner as to increase the coupling efficiency of the diode to the fibre. The hole in the centre of the metal plate, has an extremely small diameter (the entire chip is about one half the size of a pin head), and requires a small glass ball or 'microlens' to be placed directly over it. The lens further directs the light into a narrow beam, allowing the light to be efficiently coupled to the fibre. This type of light source is usable for data rates up to about 80 MHz. For even greater data rate, another diode, called the 'Burrus' or 'etched-well' diode, was developed. This special diode has an even smaller light emitting area and can be used to efficiently couple light to a very thin monomode step-index fibre. Also, due to its special construction, designed to dissipate the heat developed, it can be utilized at very high data rates. Another special light emitting diode was designed to emit light in a very small, directional beam. This is known as an 'edge emitting' diode. With this type of diode, the light is not radiated out of the top of the chip as in the others, but rather is directed out one end of a special internal chamber which opens at the edge of the diode. This type of light emitting diode offers very efficient coupling of the light source to the optic fibre, and can be employed in systems that have a high data rate and long distances. The edge-emitting diode is very similar to the injection laser diode, and does not require a large current source. All of the special light emitting diodes mentioned are, needless to say, much more expensive than the ordinary planar LED.

Getting It Out Again

To receive the light at the far end of the fibre optic system, a photodiode, phototransistor, or special 'receivers' can be employed. For use in a very short distance system, a photodiode or phototransistor would be sufficient. For distances bet-



final coupling to the receiver at the far end. In the overall design of the system, the amount of power supplied by the light source, less all the losses incurred, must still allow sufficient power for detection by the receiver at the far end.

Each of the areas discussed, fibres, receivers, LEDs, couplers, and splicers, are currently undergoing rapid changes. Every day, it seems, brings newer, more sophisticated and cheaper fibre optic products into the market place. With such rapid development underway, the use of these high technology products will soon invade every business and home that currently sports a telephone or cable TV line. The telecommunications companies are constantly breaking new ground in both product design and application methods.

ETI

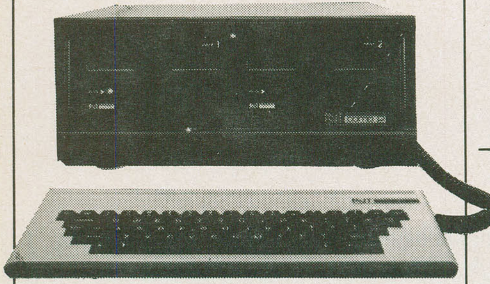
ween 10 and 100 metres, a special receiver circuit can be employed. These receivers consist of a photodetector, an amplifier, an automatic gain control, and a signal reshaper, all on one small chip enclosed in a TO-5 case. The case has a plastic cap to allow for easy press-fit alignment to the fibre. Low cost versions offer data rates from between DC to 200,000 bits per second. Receivers of this type are called 'Fibre Optic Schmitt Detectors'. For distances greater than 100 metres, the receivers employed are the same as the previous one, with the addition of a special 'timing recovery' circuit. Again, all the circuits required are built on a single small chip.

There are many areas that require special consideration in the design of a fibre optic system in order to minimize losses. The system will exhibit a certain amount of loss at the coupling of the light source to the fibre, due to some of the light being reflected off the polished surface of the fibre (fresnel loss), or improper angle of radiation causing much of the light to be refracted, among other things. The optic fibre itself will cause a certain amount of loss due to absorption. The fibre will also fail to carry the light if it is forced to bend around a very sharp corner, as all the light will strike the surface at an angle less than the critical angle and will be refracted into the cladding and lost. Each splice encountered in the system will also introduce loss, as will the

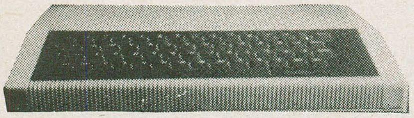
Survey of 50 Systems

HEREIN we present 50 of the lower-cost computers available in Canada. As always, we're sure it's complete and perfect; as always, the inevitable on-going changes in the market prevent this from ever happening.

A word about prices: they are the manufacturer's suggested list price, because various dealers sell at different prices. Don't be surprised if they're different when you get to the store. However, you can use them as a rough comparison guide.



System:	AVT Comp 2
Operating System:	BASIC
Processors:	6502
RAM:	64K
Printer I/O:	7 Exp Slots
Disk Drives Inc:	Optional floppy
Screen Format:	40x24
Graphics:	280x193
Sound:	N
Colour:	Y
Keyboard:	Detachable
Software Included:	Basic
Software Available:	Fortran, COBOL, PASCAL, etc
Primary Market:	Personal or Business
Manufacturer:	AVT, Switzerland
Available From:	Interactive Micro Systems
Price:	$1695.00
Other:	7 Apple compatible I/O slots



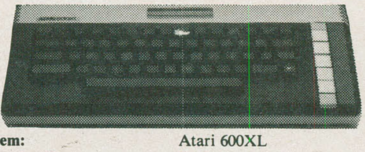
System:	Acorn Atom
Operating System:	BASIC
Processors:	6502
RAM:	2K
Printer I/O:	Opt S or P
Disk Drives Inc:	Opt
Screen Format:	32x16
Graphics:	256x192
Sound:	Y
Colour:	Opt
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	Extensive
Primary Market:	Home
Manufacturer:	Acorn Computers
Available From:	Gladstone
Price:	$199.95
Other:	

System:	ACE 1200
Operating System:	CP/M
Processors:	6502, Z80A
RAM:	128K
Printer I/O:	S, P & 3 Exp
Disk Drives Inc:	SS floppy diskette
Screen Format:	40(80)x24
Graphics:	280x192
Sound:	N
Colour:	Y
Keyboard:	Integrated
Software Included:	CP/M, Apple BASIC
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Franklin Computers
Available From:	Local dealers
Price:	$1399.00
Other:	Plug Apple compatible

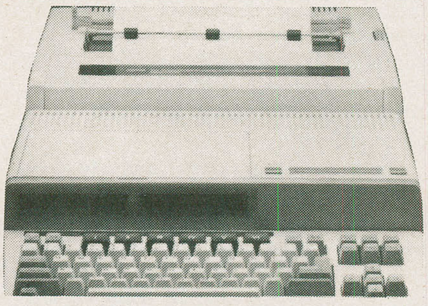
System:	ACE 1000
Operating System:	BASIC
Processors:	6502
RAM:	64K
Printer I/O:	8 Exp
Disk Drives Inc:	Opt
Screen Format:	40x24
Graphics:	280x192
Sound:	N
Colour:	Opt
Keyboard:	Integrated
Software Included:	Apple Comp BASIC
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Franklin Computers
Available From:	Local dealers
Price:	$1399.00
Other:	Plug Apple compatible

System:	Aquarius
Operating System:	BASIC
Processors:	Z80A
RAM:	4K
Printer I/O:	S
Disk Drives Inc:	Opt or cassette
Screen Format:	40x24
Graphics:	320x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated, Qwerty
Software Included:	BASIC
Software Available:	CP/M Compatible
Primary Market:	Home
Manufacturer:	Mattel Electronics
Available From:	Electronic Playworld
Price:	$199.00
Other:	Disk drive not available until late '83

System:	Atari 1200XL
Operating System:	BASIC
Processors:	6502
RAM:	64K
Printer I/O:	S
Disk Drives Inc:	Opt
Screen Format:	40x24
Graphics:	280x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	Basic
Software Available:	Extensive
Primary Market:	Home or Business
Manufacturer:	Atari
Available From:	Irwin Electronics
Price:	$949.00
Other:	CP/M Opt

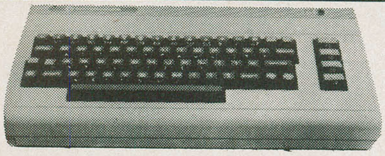


System:	Atari 600XL
Operating System:	BASIC
Processors:	6502
RAM:	16K
Printer I/O:	P
Disk Drives Inc:	Opt Disk or Recorder
Screen Format:	40x24
Graphics:	320x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	Atari Basic
Software Available:	Over 1000 programs
Primary Market:	Home
Manufacturer:	Atari
Available From:	Irwin Electronics
Price:	$249.00
Other:	CP/M Opt



System:	Coleco Adam
Operating System:	
Processors:	Z80A
RAM:	80K
Printer I/O:	S & 4 I/O ports
Disk Drives Inc:	Digital cassette (50 IPS)
Screen Format:	36x25
Graphics:	High res
Sound:	Y
Colour:	N
Keyboard:	Detachable
Software Included:	Smartwriter, Smartbasic, game
Software Available:	Atari games, Apple Basic Compatible
Primary Market:	Home or Business
Manufacturer:	Coleco
Available From:	Consumers, Sears, Bay, Eatons
Price:	$1200.00
Other:	Letter quality printer included

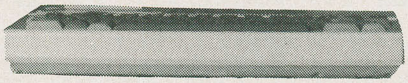
Computer Survey



System:	Commodore 64
Operating System:	Basic
Processors:	6510
RAM:	64K
Printer I/O:	S
Disk Drives Inc:	One 5¼" floppy
Screen Format:	40x25
Graphics:	320x200
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	Software on disk
Software Available:	Extensive
Primary Market:	Home
Manufacturer:	Commodore
Available From:	Local dealers
Price:	$1299.95
Other:	Price includes disk, desk, CPU, & keyboard

System:	CBM 128-80
Operating System:	
Processors:	6509 & 8088
RAM:	128K
Printer I/O:	IEEE
Disk Drives Inc:	Opt disks
Screen Format:	80x25
Graphics:	720x350
Sound:	Y
Colour:	N
Keyboard:	Detachable
Software Included:	Not finalized
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Commodore
Available From:	Local Dealers
Price:	N/A
Other:	Also available with 256K

System:	Dragon 32
Operating System:	BASIC
Processors:	6809E
RAM:	32K
Printer I/O:	P
Disk Drives Inc:	Cassette
Screen Format:	32x16
Graphics:	256x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	Basic
Software Available:	Extensive
Primary Market:	Home
Manufacturer:	Dragon Data Ltd.
Available From:	Dragon Data (Canada) Ltd.
Price:	$399.00
Other:	

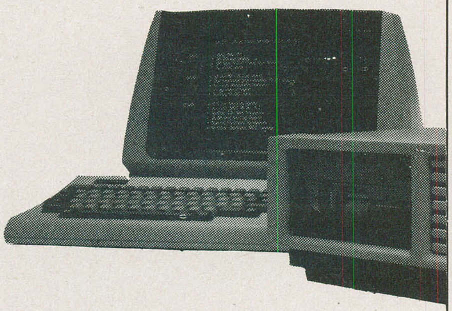


System:	EPSON HX-20
Operating System:	BASIC
Processors:	6301
RAM:	16K
Printer I/O:	S & P
Disk Drives Inc:	Opt Micro cassette
Screen Format:	20x4 LCD
Graphics:	120x32
Sound:	Y
Colour:	N
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	
Primary Market:	Business
Manufacturer:	Epson
Available From:	Essna
Price:	$1099.00
Other:	Portable, price inc's printer

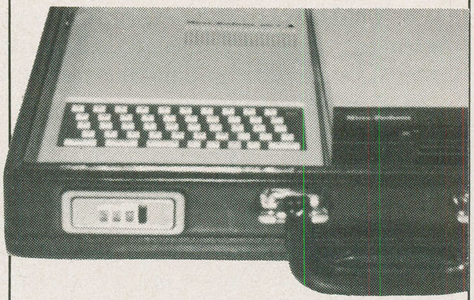
System:	Expander
Operating System:	CP/M
Processors:	Z80A
RAM:	64K
Printer I/O:	S, P & 4 Exp
Disk Drives Inc:	5¼" or 8" floppy with CP/M
Screen Format:	40x24 colour
Graphics:	80x72 colour
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	CP/M
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	California Computer Systems
Available From:	Orion Electronics Supplies Inc.
Price:	$1550.00
Other:	Included floppy, IEEE disk control

System:	HP-75C
Operating System:	BASIC
Processors:	CMOS
RAM:	16K
Printer I/O:	HP-IL
Disk Drives Inc:	Cassette, built-in card reader
Screen Format:	32 character window
Graphics:	N/A
Sound:	N
Colour:	N
Keyboard:	Touch-type
Software Included:	BASIC
Software Available:	Application Software
Primary Market:	Business
Manufacturer:	Hewlett Packard
Available From:	Hewlett Packard
Price:	$1687.00
Other:	Portable and battery operated

System:	LIC-3001
Operating System:	BASIC
Processors:	Z80A & 6502
RAM:	64K
Printer I/O:	P
Disk Drives Inc:	Opt 5¼" floppy
Screen Format:	80x24
Graphics:	280x192
Sound:	Y
Colour:	Y
Keyboard:	Detachable
Software Included:	BASIC
Software Available:	Extensive, CP/M or DOS Compatible
Primary Market:	Business
Manufacturer:	Mitac, Taiwan
Available From:	Micro Computech Electronics
Price:	$995.00
Other:	Apple II compatible, portable



System:	Micro Decision
Operating System:	CP/M
Processors:	Z80A
RAM:	64K
Printer I/O:	2 S
Disk Drives Inc:	One SS 5¼" floppy
Screen Format:	80x24
Graphics:	N/A
Sound:	N
Colour:	N
Keyboard:	Detachable
Software Included:	BASIC, Wordstar, Logicalc, Correct-It
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Morrow Designs
Available From:	EMJ Data Systems Ltd.
Price:	$2125.00
Other:	

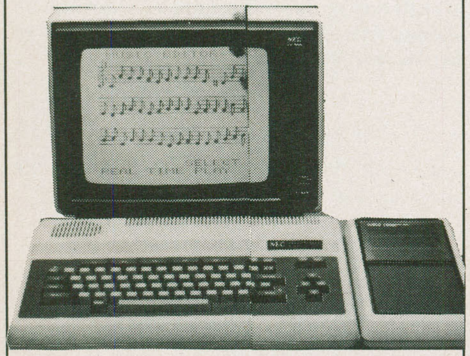


System:	Micro-Professor
Operating System:	BASIC
Processors:	6502
RAM:	64K
Printer I/O:	P
Disk Drives Inc:	Opt cassette or disk drives
Screen Format:	40x24
Graphics:	280x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated, Qwerty
Software Included:	BASIC
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Multitech Ind. Corp.
Available From:	Polytech Int. Canada Ltd.
Price:	$600.00
Other:	Portable

Computer Survey

System:	M5
Operating System:	BASIC
Processors:	Z80A
RAM:	20K
Printer I/O:	P
Disk Drives Inc:	Opt cassette
Screen Format:	24x40 (TV)
Graphics:	N/A
Sound:	Y
Colour:	Y
Keyboard:	Integrated, Qwerty
Software Included:	BASIC
Software Available:	Available from Sord
Primary Market:	Home
Manufacturer:	Sord
Available From:	Micos Computer Systems Inc.
Price:	N/A
Other:	Portable

System:	Micro 48 Model II
Operating System:	Apple Compatible
Processor:	6502
RAM:	48K
Printer I/O:	Optional
Disk Drive:	Optional
Screen Format:	40 x 24
Graphics:	Med. res.
Sound:	No
Colour:	No
Keyboard:	Integrated
Software Inc.:	Basic
Software Avail.:	Extensive
Primary Market:	Home or business
Manufacturer:	Micro
Available From:	Gladstone
Price:	$488.00

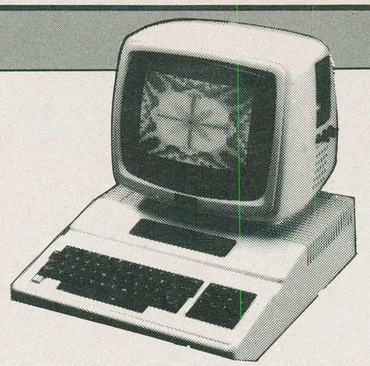


System:	NEC PC-6000
Operating System:	BASIC
Processors:	PD780C-1
RAM:	16K
Printer I/O:	P
Disk Drives Inc:	Opt disk drive or recorder
Screen Format:	32x16
Graphics:	356x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	Extensive, Supports DOS
Primary Market:	Home
Manufacturer:	NEC
Available From:	Microcomputers of Canada Inc.
Price:	$449.95
Other:	Processor is Z80 compatible

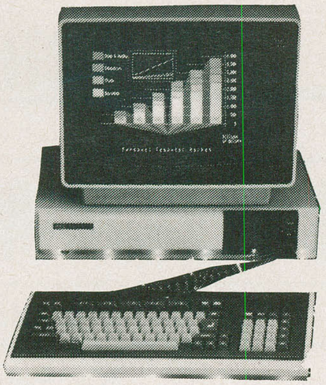
System:	PC 1500
Operating System:	BASIC
Processors:	C-MOS
RAM:	2.6K
Printer I/O:	Optional Printer-cassette interface
Disk Drives Inc:	Optional Printer-cassette interface
Screen Format:	26x1 LCD
Graphics:	7x156
Sound:	Y
Colour:	N
Keyboard:	Qwerty
Software Included:	BASIC
Software Available:	
Primary Market:	Home or Business
Manufacturer:	Sharp
Available From:	Total Office Systems Ltd
Price:	$299.95
Other:	Battery operated, portable

System:	NABU Personal
Operating System:	CP/M, IOS
Processors:	Z80A
RAM:	64K
Printer I/O:	S, P & 4 Exp
Disk Drives Inc:	Opt SS DD 5¼" floppy or cassette
Screen Format:	40x24
Graphics:	256x192
Sound:	Programmable
Colour:	Y
Keyboard:	Detachable
Software Included:	BASIC, PASCAL, LOGO
Software Available:	Extensive
Primary Market:	Home or Business
Manufacturer:	NABU
Available From:	Local dealers
Price:	$995.00
Other:	Portable, network

System:	NEC 8001 A
Operating System:	BASIC
Processors:	PD780C-1
RAM:	32K
Printer I/O:	P & S
Disk Drives Inc:	Cassette or opt disk I/O unit
Screen Format:	80x25
Graphics:	160x100
Sound:	N
Colour:	Opt
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	Extensive, CP/M compatible
Primary Market:	Business
Manufacturer:	NEC
Available From:	Microcomputers of Canada
Price:	$1495.00
Other:	Processor is Z80 compatible



System:	Spiral II
Operating System:	BASIC
Processors:	6502
RAM:	48K
Printer I/O:	8 Exp
Disk Drives Inc:	Opt disks or cassette
Screen Format:	40x24
Graphics:	280x192
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	Extensive
Primary Market:	Personal
Manufacturer:	Golden Computers
Available From:	Spiral Computers
Price:	$649.00
Other:	Apple compatible



System:	PC 8800
Operating System:	BASIC
Processors:	PD780C-1
RAM:	64K
Printer I/O:	P, S & 4 Exp
Disk Drives Inc:	5¼" & 8" floppy interfaces
Screen Format:	80x25
Graphics:	640x200
Sound:	N
Colour:	Opt
Keyboard:	Detachable
Software Included:	Two Basics
Software Available:	Extensive, CP/M compatible
Primary Market:	Business
Manufacturer:	NEC
Available From:	SGV Marketing
Price:	$1795.00
Other:	Processor is Z80 compatible

System:	PC-8201
Operating System:	Proprietary
Processor:	80C85
RAM:	16K
Printer I/O:	Yes
Disk Drive:	No
Screen Format:	40 X 80 LCD
Graphics:	Block
Sound:	Yes
Colour:	No
Keyboard:	Integrated
Software Inc.:	BASIC, textfiles, Telecom, plus cassette, etc.
Software Avail.:	Limited
Primary Market:	Home and business
Manufacturer:	NEC
Available From:	Microcomputers of Canada
Price:	$1195.00

Continued from page 68

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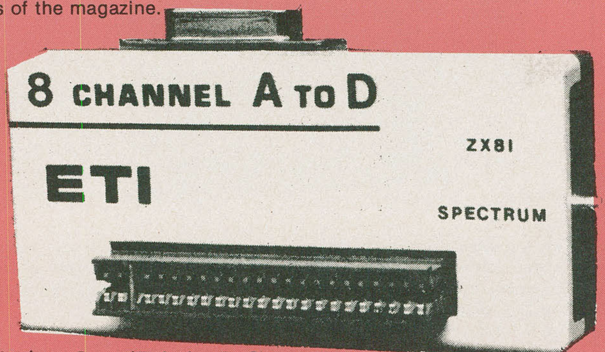
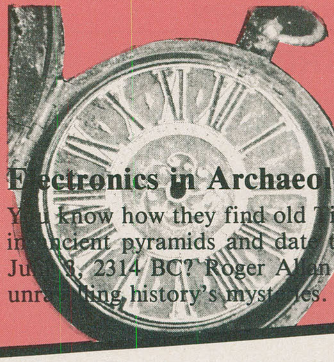


ZX81 Analog/Digital Converter

An 8-channel ADC with 8-bit resolution to let your ZX communicate with the Real World; careful though, ours got a taste of freedom and ran off with a food processor.



Electronics in Archaeology

You know how they find old Timex pocket watches and stuff in ancient pyramids and date them to Wednesday morning, Ju[illegible] 3, 2314 BC? Roger Allan explains the methods used in unravelling history's mysteries.

Electronic Mail

Roger Allan investigates another technological miracle: getting the Post Office to work at the speed of light.

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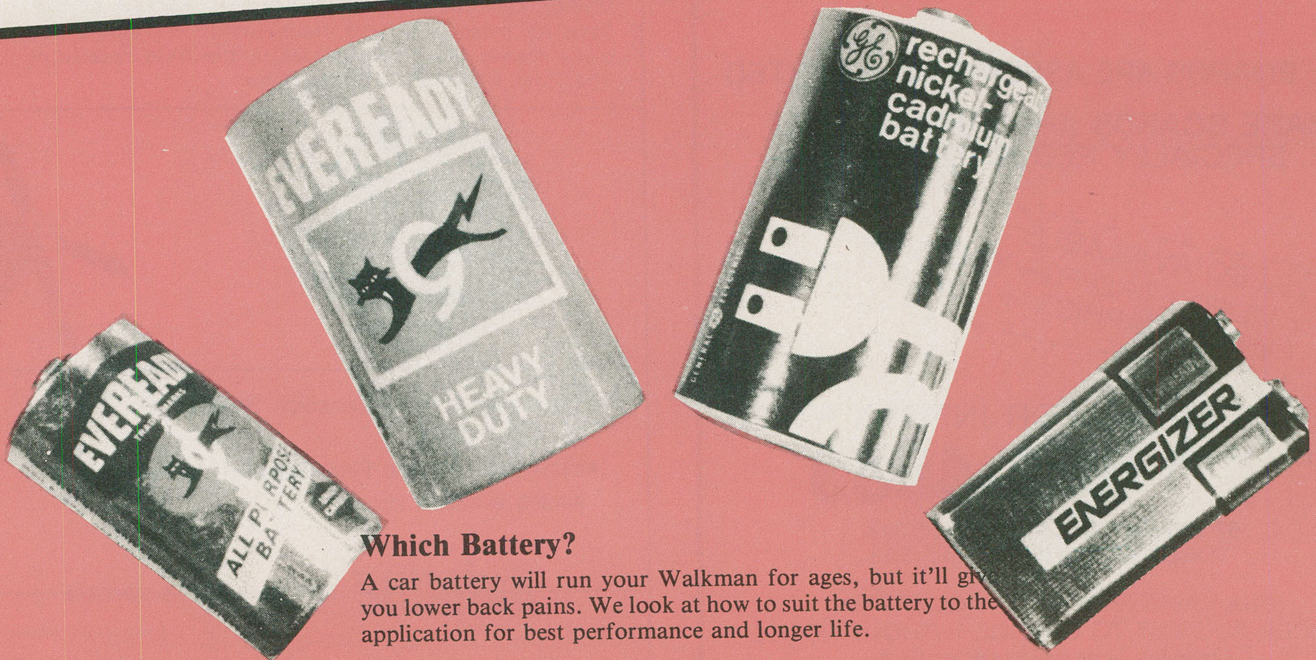

Which Battery?

A car battery will run your Walkman for ages, but it'll give you lower back pains. We look at how to suit the battery to the application for best performance and longer life.

Product Review
Fluke 70 Series DVM

The DVM has been re-thought. Bill Markwick looks at Fluke's new 70 Series handhelds.

WHAT? ANOTHER handheld? Ho hum, send me a couple of dozen; the kids can build play-houses with 'em. Oh, it's really new, you say? Okay, let's have a look here . . . hmmm, no mess of buttons down the side, and what's this? An analog bargraph? An automatic display latch? Put all my calls on hold, I'm going in the workshop for a couple of hours to play with this thing.

First Impressions

If you're trying to get a circuit working again, and everything is going wrong at once, the last thing you need is test equipment that wants special attention; it should just do its job transparently, as they say in computer-speak. For this reason, I've never been partial to those DVMs that require puzzling out a row of pushbuttons whenever you want to change functions or ranges. Fluke has solved the problem by using a large rotary function switch conveniently mounted to fall under your left thumb, and it includes autoranging to minimize control-fiddling.

The next thing you notice when you pick it up is the remarkable solidity of the case; it's supposed to survive a lengthy drop onto a hard surface, and it certainly feels rugged enough to do just that. Included with the Model 77, and optional on the others, is a rubbery holster that serves as either an upright stand or a belt clip; inserted into this holster, the meter feels as if you could drive concrete nails with it. The holster also includes a neckstrap; a flexible clip on the end of the holster lets you sit the meter horizontally on your belt, freeing both hands for testing. The probe leads can be inserted into holders into the back of the holster.

The Models

Three versions are offered: the 73, 75 and 77. All models feature autoranging, an analog bargraph, a continuity beeper, and 3½ digits. The basic differences between them are the accuracy specification and the manual range function. In a nutshell: The **Model 73** at $125 has 0.7% DC accuracy and autorange only. The **Model 75** at $145 has 0.5% DC accuracy, auto and manual ranging. The **Model 77** at $185 has 0.3% DC accuracy, auto and manual ranging, plus Touch Hold, a marvelous display latch which I'll get to in a moment.

The Display

It isn't really accurate to call them 3½ digit meters. As you can see from the photograph, the half-digit goes up to three. This gives you 3200 counts per range, and extends the ohms range to 32 megohms. The digits are updated 2.5 times per second, and the 30-segment bargraph 25 times per second.

The Functions

The usual: AC volts, good for 3% on the 73 and 2% on the others with a frequency response of 45 Hz to 1 KHz. DC volts as mentioned above, including a 300 mV range with a resolution of 0.1 mV. Ohms to 32 meg, and a continuity beeper which also displays the forward voltage of diodes. Moving the test leads will give you AC and DC milliamperes up to 300, and moving them once again extends the current range to 10 amperes.

The Bargraph

Have you ever tried to trim some sort of calibration level with a digital meter flipping and flashing and trying to make up its mind where to settle? The analog bargraph is just the ticket here; its rapid 25/sec updating means that you can get some idea of what's happening with less-than-ideal signals. Another use would be when two signals beat together to cause some low-frequency swaying of the level;

the bargraph at least clues you in that the digital display isn't having fits. The 30 segments don't give you the best possible resolution, but after all, you're dealing with a compromise.

Touch Hold

In a previous life as a technician, I always seemed to be working upside down with my head stuck in somebody's equipment console trying desperately to make a reading and watch the meter at the same time. Maybe my whole career would have changed if I had owned a Fluke 77; it includes the best feature of all, the remarkable Touch Hold. In this mode, you touch the probes to the test point, and the meter peeps to let you know that it's found something out. You then casually crawl out from under the equipment rack, straighten your tie, and read the display at your leisure. The reading will be held until you re-apply the probes; it will then automatically update itself.

I think Fluke will have a warehouse full of 73s and 75s once people try the 77's Touch Hold feature.

Accessories

All kinds of them: a case, deluxe leads, temperature probes, RF probes, HV probes, high-current clamps. The only option I missed was a True-RMS function; the Fluke designers felt that this was a specialty feature which would raise the cost of the meter. Maybe somebody will develop a little add-on box.

Miscellaneous

As you've probably gathered by now, I thought using the meter was a delight; the display was updated quickly and solidly with no blurring of digits. The digits, by the way, quietly go away after an hour if you should leave the meter and forget to turn it off; they return to life if you operate the rotary switch. A nice touch, though you get better than 2000 hours with an alkaline battery anyway.

Other stuff: all voltage ranges have greater than 10 megohms input impedance; overload is 1000 VDC or 750 VAC, or 500 V on the Ohms range. The ranges on the 75 and 77 are changed by pressing the range button; each press steps the decimal point one place.

I suppose to make this an objective review, I should find something wrong with it, but I'd have to be awfully picky. The meter does everything it's supposed to, and superbly at that.

And Finally . . .

The Fluke 70 Series, and all other Fluke equipment, is available across Canada from Allan Crawford Associates Ltd., with branches in Mississauga, Montreal, Ottawa, Halifax, Vancouver, Calgary, and Edmonton.

ETI

Military Lasers

Will the real Buck Rogers please sit down? Plans are afoot to build weapons normally associated with Hollywood sci-fi. Roger Allan separates the reality from the wishful thinking.

WITH THE Reagan Administration announcement some months ago that the United States was to embark on a massive military upgrading program, an embarkation which is to include development of particle beam and laser weapons systems, a veritable panoply of articles and commentary has descended on the unsuspecting public. The possibility of Buck Rogers type warfare is dealt with, on a scale previously unimagined. As with most such **Star Wars** articles, a great deal has been written which is essentially nonsense, better confined to the pages of second-rate science fantasy articles than to the quality publications in which such material so frequently appears. The separation of the fantasy from the fact, in the public's mind, has become increasingly difficult as more and more supposed experts vent their opinions on subjects without really explaining what they mean, how much is reality, how much is potentially possible and how much is just wishful thinking. When one digs into the primary data on this subject, however, one finds that it is quite easy to separate the wheat from the chaff, as it were, and it mostly turns out to be chaff.

To begin at the beginning. The development of a laser-damage weapon system was felt by the military to have some particularly attractive features. For example, since light travels at a speed of 186,000 miles per second, the lethal flux would arrive at the target almost instantaneously, and there would be no requirement to lead the target, except at very long ranges. It takes six millionths of a second for laser light to travel one mile, and in that time, a supersonic airplane travelling at twice the speed of sound will travel only a little more than one-eighth of an inch. Also, a laser weapon could be used to selectively attack and destroy single enemy targets in the midst of a host of friendly vehicles or equipment.

Laser Basics

But first a laser of sufficient power had to be developed, one which could produce power in the range of megawatts. Although many different lasers were discovered in the 1960s, none was suitable for high energy applications. In the mid-60s, a discovery led to efficient lasers which generated their energy in the infrared portion of the spectrum. A con-

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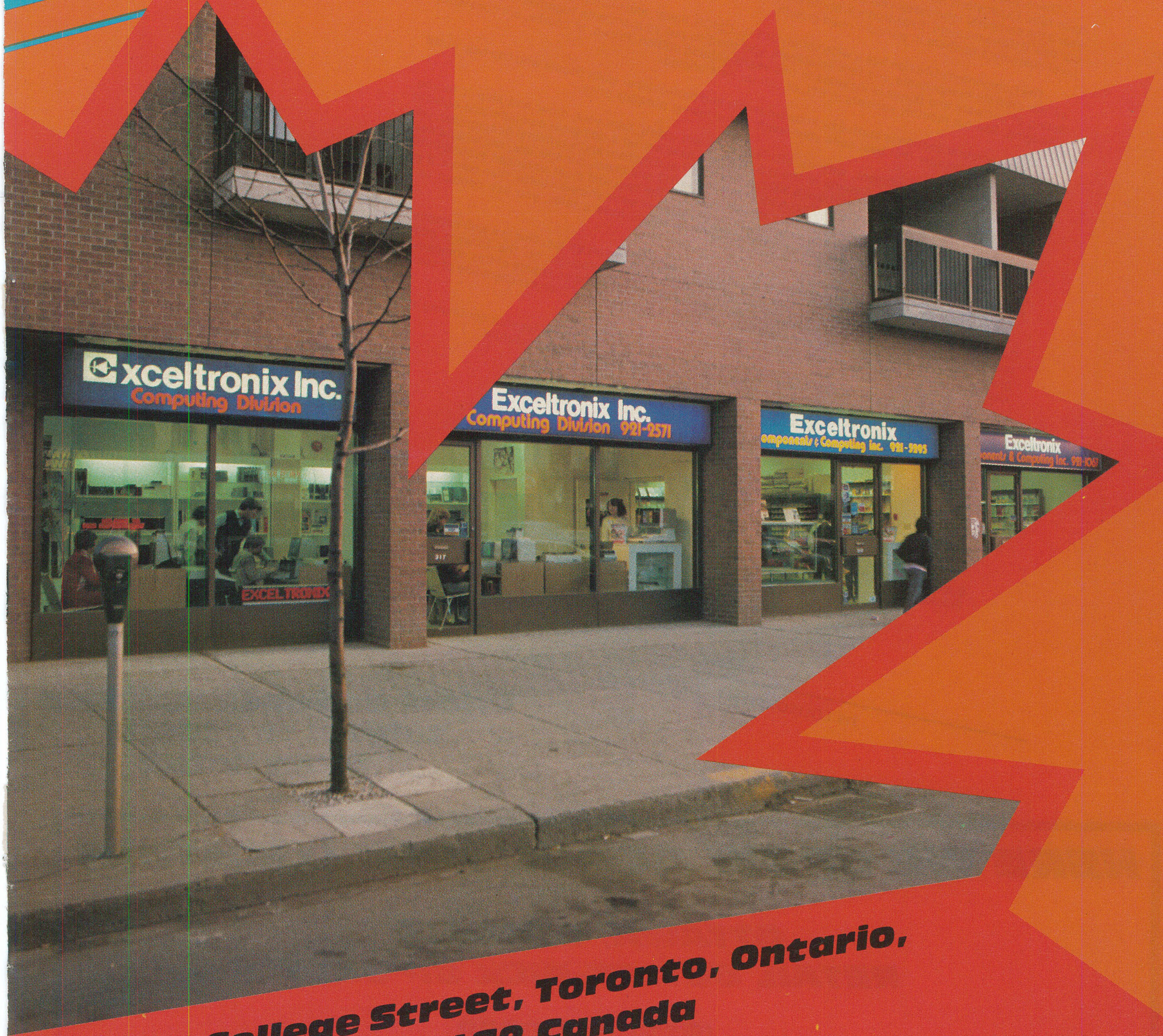

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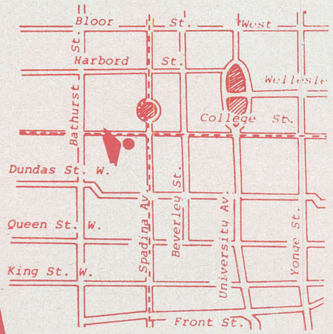

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7400 Series TTL

7400	Quad 2 input NAND gate	.34
7401	Quad 2 input NAND gate O/C	.34
7402	Quad 2 input NOR gate	.34
7403	Quad 2 input NOR gate O/C	.34
7404	Hex inverter	.37
7405	Hex inverter O/C	.37
7406	Hex inverter buffer/driver	.89
7407	Hex inverter buffer/driver	.89
7408	Quad 2 input AND gate	.34
7409	Quad 2 input AND gate O/C	.34
7410	Triple 3 input NAND gate	.34
7411	Triple 3 input NAND gate O/C	.37
7412	NAND gate inverter	.44
7413	Dual Schmidt trigger	.49
7414	Hex Schmidt trigger	.54
7416	Hex inverter buffer/driver	.49
7417	Hex buffer driver	.49
7420	Dual 4 input NAND gate	.34
7421	Dual 4 input NAND gate	.44
7422	Dual 4 input NAND gate O/C	.49
7423	Dual 4 input positive NOR	.58
7425	Dual 4 input NOR	.44
7427	Triple 3 input NOR	.44
7428	Quad 2 input NOR buffer	.58
7430	8 input NAND gate	.37
7432	Quad 2 input NOR buffer	.44
7433	Quad 2 input NOR buffer O/C	.44
7437	Quad 2 input NAND buffer	.44
7438	Quad 2 input NAND buffer O/C	.44
7439	Quad 2 input NAND buffer	1.47
7440	Dual 4 input NAND buffer	.44
7442	BCD-to-decimal decoder	.62
7445	BCD to decimal decoder/driver	1.65
7448	BCD to decimal decoder/driver	1.65
7470	Edge triggered JK flip-flop	.44
7472	JK master/slave flip flop	.49
7473	Dual JK flip flop with clear	.49
7474	Dual D flip flop	.49
7475	4 bit bistable latch	.54
7476	Dual JK master/slave flip flop	.49
7480	Gated full adder	.82
7482	2 bit binary full adder	1.81
7483	4 bit binary full adder	.89
7485	4 bit magnitude comparator	.89
7486	Quad 2 input XOR gate	.50
7489	64 bit RAM	2.78
7490	Decade counter	.54
7491	8 bit shift register	.78
7492	Divide by 12 counter	.54
7493	4 bit binary counter	.54
7494	4 bit shift register (parr. in, ser. out)	.89
7495	4 bit right/left shift register	.72
7496	5 bit shift register async. preset	.79
7497	Sync. 6 bit binary rate multiplier	2.37
74100	8 bit bistable latch	1.81
74104	Gated JK master/slave flip/flop	1.34
74105	Gated JK master/slave flip/flop	1.34
74107	Dual JK flip flops with clear	.58
74109	Dual JK positive edge triggered flip flop	.58
74110	AND gated JK master/slave flip flop	.67
74111	Dual JK master/slave flip flop	.82
74116	Dual 4 bit latch	1.81
74120	Dual pulse syncronizer/driver	1.81
74121	Monostable multivibrator	.54
74122	Retriggerable monostable multivibrator	.72
74123	Dual retriggerable monostable multivibrator	.74
74125	Tri-state quad bus buffer	.72
74126	Tri-state quad bus buffer	.72
74132	Quad 2 input Schmitt trigger NAND	.74
74136	Quad 2 input XOR gate	.74
74141	BCD to decimal decoder/driver	1.53
74142	Counter/latch/decoder/driver	4.85
74143	Counter/latch/decoder/driver	4.85
74144	Counter/latch/decoder/driver	4.85
74145	BCD to decimal decoder/driver	.89
74147	10-4 priority encoder	1.89
74148	8-3 priority encoder	1.34
74150	16-1 multiplexer	1.57
74151	8 channel digital multiplexer	.67
74153	dual 4-1 multiplexer	.67
74154	4-16 decoder/demultiplexer	1.57
74155	Decoder/demultiplexer	.67
74156	Decoder/demultiplexer	.87
74157	Quad 2 input multiplexer	.74
74159	4-16 decoder/demultiplexer O/C	1.95
74160	Decade counter with async. clear	.89
74161	Sync. 4 bit counter	.89
74162	Sync. 4 bit counter	.89
74163	Sync. 4 bit counter	.89
74164	8 bit serial shift register	.89
74165	Parallel load 8-bit shift register	1.09
74166	8 bit shift register	1.09
74167	Sync. rate multiplier	3.64
74174	Hex D flip flop with clear	.72
74175	Quad D flip flop with clear	.72
74176	Presettable decade counter/latch	1.06
74177	Presettable binary counter/latch	1.06
74178	4 bit universal shift register	1.67
74179	4 bit parallel access shift register	1.67
74180	9 bit odd/even parity generator/checker	.99
74181	ALU	2.74
74182	Look ahead carry generator	1.17
74184	Code convertor BCD to binary	2.75
74185	Binary to BCD convertor	2.74
74190	Sync. up/down counter BCD	1.01
74191	Sync. up/down counter binary	1.01
74192	Binary up/down counter	.42
74193	Binary up/down counter	.42
74194	4 bit bi-directional shift register	.96
74195	4 bit parallel access shift register	.96
74196	Presettable decade counter	1.17
74197	Presettable binary counter	1.17
74198	8 bit shift register	1.75
74199	8 bit shift register	1.75
74221	Dual Monostable multivibrator	1.09
74251	Tri-state data selector multiplexer	1.10
74259	8 bit addressable latch	2.58
74265	Quad complementary output elements	.91
74273	Octal D flip flop	2.58
74276	Quad JK flip flop	3.16
74278	4 bit cascadable priority register	3.44
74279	Quad S-R latches	.96
74283	4 bit binary full adder	1.67
74285	Tri-state 4 bit multiplexer	4.49
74290	Decade counter	1.09
74293	4 bit binary counter	1.09
74298	Quad 2 input multiplexer	1.09
74351	Dual 8-1 multiplexer	3.09
74365	Hex bus drivers	.75
74366	Hex bus drivers inverting	.75
74367	Hex bus drivers	.75
74368	Hex bus drivers inverting	.75
74376	Quad JK flip flop	.85
74390	Dual decade counter	1.57
74393	Dual 4 bit binary counter	1.99

74S00 Series TTL

74S00	Quad 2 input NAND gate	$ .44
74S02	Quad 2 input NOR gate	.44
74S03	Quad 2 input NOR gate O/C	.44
74S04	Hex inverter	.49
74S05	Hex inverter O/C	.49
74S08	Quad 2 input AND gate	.44
74S09	Quad 2 input AND gate O/C	.44
74S10	Triple 3 input NAND gate	.44
74S11	Triple 3 input NAND gate O/C	.44
74S15	Triple 3 input AND gate O/C	.44
74S20	Dual 4 input NAND gate	.44
74S22	Dual 4 input NAND gate O/C	.44
74S30	8 input NAND gate	.44
74S32	Quad 2 input NOR buffer	.57
74S37	Quad 2 input NAND buffer	1.23
74S38	Quad 2 input NAND buffer O/C	1.23
74S40	Dual 4 input NAND buffer	.49
74S74	Dual D flip flop	.66
74S85	4 bit magnitude comparator	1.94
74S86	Quad 2 input XOR gate	.75
74S109	Dual JK positive edge triggered flip flop	1.65
74S112	Dual JK flip flop	.87
74S113	Dual JK negative edge triggered flip flop	.87
74S114	Dual JK negative dge triggered flip flop	.87
74S124	Dual VCO	3.15
74S132	Quad 2 input Scmitt trigger NAND	1.69
74S128	3-8 decoder/multiplexer	1.17
74S139	Dual 2-4 decoder/multiplexer	1.17
74S140	Quad line driver	.78
74S151	8 channel digital multiplexer	1.17
74S153	Dual 4-1 multiplexer	1.35
74S157	Quad 2 input multiplexer	1.35
74S158	Quad 2 input multiplexer	1.34
74S160	Decade counter with async. clear	3.72
74S161	Sync. 4 bit counter	3.44
74S162	Sync. 4 bit counter	3.72
74S163	Sync. 4 bit counter	2.75
74S168	4 bit up/down sync. counter	5.44
74S169	4 bit sync. counter	5.13
74S174	Hex D flip flop with clear	1.56
74S175	Quad D flip flop with clear	1.56
74S181	ALU	3.94
74S182	Look ahead carry generator	2.00
74S189	16 x 4 RAM	3.87
74S195	4 bit parallel access shift register	1.97
74S196	Presettable decade counter	3.16
74S197	Presettable binary counter	3.16
74S201	256 bit RAM	6.95
74S240	Octal line driver	2.24
74S241	Octal line driver	2.24
74S244	Octal line driver	3.09
74S251	Tri-state data selector multiplexer	1.51
74S260	Dual 5 input NOR gate	.93
74S274	4 x 4 binary multiplier	17.89
74S275	7 bit slice wallace tree	17.89
74S283	4 bit binary full adder	3.44
74S289	16 x 4 RAM	4.10
74S299	8 bit universal shift storage register	7.84
74S373	Octal D latch	2.74
74S374	Octal D latch	2.74

74LS00 Series TTL

74LS00	Quad 2 input NAND gate	$ .34
74LS01	Quad 2 input NAND gate O/C	.34
74LS02	Quad 2 input NOR gate	.34
74LS03	Quad 2 input NOR gate O/C	.34
74LS04	Hex inverter	.34
74LS05	Hex inverter O/C	.34
74LS08	Quad 2 input AND gate	.34
74LS09	Quad 2 input AND gate O/C	.34
74LS10	Triple 3 input NAND gate	.34
74LS11	Triple 3 input NAND gate O/C	.34
74LS12	NAND gate inverter	.34
74LS13	Dual Schmidt trigger	.54
74LS14	Hex Schmidt trigger inverter	.62
74LS15	Triple 3 input NAND gate	.50
74LS20	Dual 4 input NAND gate	.34
74LS21	Dual 4 input NAND gate	.36
74LS22	Dual 4 input NAND gate	.50
74LS24	Quad 2 input NAND Schmidt trigger	.78
74LS26	Quad 2 input positive NAND gate	.44
74LS27	Triple 3 input NOR gate	.34
74LS28	Quad 2 input NOR buffer	.50
74LS30	8 input NAND gate	.34
74LS32	Quad 2 input NOR gate	.44
74LS33	Quad 2 input NOR gate O/C	.50
74LS37	Quad 2 input NAND gate	.44
74LS38	Quad 2 input NAND gate O/C	.44
74LS42	BCD to decimal decoder	.58
74LS47	BCD to 7 segment decoder/ driver	.86
74LS48	BCD to 7 segment decoder/ driver	1.17
74LS49	BCD to 7 segment decoder/ driver	1.05
74LS51	And/or invert gate	.34
74LS54	4 wide and/or invert gate	.34
74LS55	2 wide 4 input and/or invert gate	.37
74LS63	Hex current sensing switch	2.58
74LS73	Dual JK flip flop with clear	.44
74LS74	Dual D flip flop	.49
74LS75	4 bit bistable latch	.54
74LS76	Dual JK master/slave flip flop	.54
74LS77	4 but bistable latch	.82
74LS78	Dual JK flip flop preset, common clear	.55
74LS83	4 bit binary full adder	.71
74LS85	4 bit magnitude comparator	.89
74LS86	Quad input XOR gate	.49
74LS90	Decade counter	.67
74LS91	8 bit shift register	.67
74LS92	Divide by 12 counter	.67
74LS93	4 bit binary counter	.67
74LS95	4 bit right/left shift register	.87
74LS96	5 bit shift register async. preset	.87
74LS107	Dual JK flip flop with clear	.49
74LS109	Dual JK pos. edge triggered flip flop	.49
74LS112	Dual JK edge triggered flip flop	.54
74LS113	Dual JK edge triggered flip flop	.54
74LS114	Dual JK edge triggered flip flop	.54
74LS122	Retriggerable monostable multivibrator	.61
74LS123	Dual retriggerable monostable multivibrator	.91
74LS125	Tri state quad bus buffer	.58
74LS126	Quad 3 state buffer	.58
74LS132	Quadruple 2 input NAND Gate	.72
74LS133	13 input NAND gate	.58
74LS136	Quad XOR gate	.54
74LS137	3 of 8 decoder/demultiplexer	.58
74LS138	3 to 8 decoder/multiplexer	.62
74LS139	Dual 1 of 4 decoder/demultiplexer	.62
74LS145	BCD to decimal decoder/driver	.91
74LS147	10/4 priority encoder	1.61
74LS148	8 to 3 line priority encoder	2.08
74LS151	8 channel digital multiplexer	.67
74LS153	Dual 4/1 multiplexer	.67

74LS154	4 to 16 decoder multiplexer	1.75
74LS155	Decoder/demultiplexer	.91
74LS156	Decoder/demultiplexer	.91
74LS157	Quad selector/multiplexer	.58
74LS158	Quad 2 input multiplexer (inverting)	.62
74LS160	Decade counter with async. clear	.81
74LS161	Sync. 4 bit counter	.91
74LS162	Sync. 4 bit counter	.91
74LS163	Sync. 4 bit counter	.91
74LS164	8 bit serail shift register	.88
74LS165	Parallel load 8 bit shift register	1.17
84LS166	8 bit PISO shift register	1.81
74LS168	Up/down decade counter	1.33
74LS169	4 bit sync. binary counter	1.33
74LS170	4 x 4 register file	1.75
74LS173	4 bit tri state register	.77
74LS174	Hex D flip flop with clear	.62
74LS175	Quad D flip flop with clear	.67
74LS181	4 bit ALU	2.74
74LS182	Look ahead carry	1.75
74LS183	Dual carry/save full adder	4.15
74LS189	64 bit RAM	4.71
74LS190	Sync. up/down counter BCD	.96
74LS191	Sync. up/down counter binary	.96
74LS192	Binary up/down counter	.91
74LS193	Binary up/down counter	.91
74LS194	4 bit bi-directional shift register	.72
74LS195	4 bit shift register	.79
74LS196	Decade counter	1.24
74LS197	Presettable binary counter	1.19
74LS219	64 bit RAM	4.71
74LS221	Dual monostable multivibrator	1.19
74LS240	Octal inverting bus driver	1.09
74LS241	Octal bus driver	1.09
74LS242	Quad inverting transceiver	1.09
74LS243	Quad transceiver	1.09
74LS244	Tri state octal driver	1.17
74LS245	Octal bus transciever	1.34
74LS227	BCD to 7 segment decoder driver	1.53
74LS248	BCD to 7 segment decoder driver	1.53
74LS249	BCD to 7 segment decoder driver	1.53
74LS251	Tristate data selector multiplexer	.68
74LS253	Dual 4 bit multiplexer	.67
74LS257	Quad 2 input multiplexer	.67
74LS258	Quad 2-1 multiplexer	.67
74LS259	8 bit addressabe latch	1.17

74LS260	Dual 5 input NOR gate	.55
74LS266	Quad 2 input XNOR O/C	.54
74LS273	Octal D flip flop	1.17
74LS275	7 bit slice Wallace tree	5.55
74LS279	Quad S-R latches	.58
74LS280	9 bit odd/even parity checker/ generator	2.30
74LS283	4 bit binary full adder	.75
74LS289	64 bit RAM	5.12
74LS290	Decade counter	.95
74LS293	4 bit binary counter	1.03
74LS295	4 bit shift register	1.20
74LS298	Quad 2 input multiplexer	1.09
74LS299	8 bit storage register	2.45
74LS319	64 bit RAM O/C	5.14
74LS320	Crystal oscillator	3.73
74LS321	Crystal oscillator	3.73
74LS322	8 bit shift register	6.53
74LS323	8 bit bidirectional universal shift	4.85
74LS348	8 to 3 priority encoder	1.17
74LS352	Dual 4 bit multiplexer	2.19
74LS353	Dual 4 bit multiplexer	1.17
74LS354	Data selector multiplexer	1.17
74LS355	Data selector multiplexer	3.65
74LS356	Data selector multiplexer	3.65
74LS357	Data selector multiplexer	3.65
74LS365	Hex bus driver tri state	.61
74LS366	Hex bus driver (inverted output)	.61
74LS367	Hex bus driver	.61
74LS368	Hex bus driver (inverted output)	.61
74LS373	Octal transparent latch	1.34
74LS374	Octal dual flip flop	1.34
74LS375	4 bit bistable latch	.67
74LS377	Octal D register	1.34
84LS378	Hex D register	1.17
74LS379	4 bit register	1.17
74LS380	Multi function octal generator	10.48
74LS381	4 bit ALU	3.43
74LS384	8 bit multiplier	7.88
74LS386	Quad 2 input XOR gate	.61
74LS390	Dual decade counter	1.34
74LS393	Dual 4 bit binary counter	1.17
74LS395	Tri state shift register	1.34
74LS396	Octal storage register	2.07
74LS398	Quad D flip flop	2.73
74LS399	Quad 2 input multiplexer with storage	1.75
74LS629	Voltage controlled oscillator	2.60

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310	Voltage follower	3.38
311	Voltage compatator	.70
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1524	Pulse width mod. reg.	15.35
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XR2567	Dual monolithic tone decoder	2.40
XR4739	Dual low noise op amp	1.55
XR14412	FSK modem system	9.39

CMOS

4000	Dual 3 input NOR gate	.25
4001	Quad 2 input NOR gate	.25
4002	Dual 4 input NOR gate	.25
4006	18 static shift register	.78
4007	Dual complementary pairs/inverters	.25
4008	4 bit full adders	.78
4009	Hex buffer/converter (inverting)	.53
4010	Hex buffer/converter	.53
4011	Quad 2 input NAND gate	.25
4012	Dual 4 input NAND gate	.25
4013	Dual D Edge triggered flip flop	.45
4014	8 bit static shift register	.78
4015	Dual 4 bit static shift register	.78
4016	Quad bilateral switch	.45
4017	Decade counter/divider	.67
4018	Presettable divide by N counter	.88
4019	Quad and/or select gate	.60
4020	14 stage binary/ripple counter	.78
4021	8 bit static shift register	.88
4022	Divide by 8 counter/divider	.97
4023	Triple 3 input NAND gate	.25
4024	7 stage binary counter	.67
4025	Triple 3 input NOR gate	.29
4026	Decade counter/divider	1.75
4027	Dual JK flip flop	.54
4028	BCD to decimal decoder	.75
4029	Presettable up/down binary/decade counter	.91
4030	Quad XOR gate	.50
4033	7 segment decaded counter	1.76
4034	8 stage universal bus register	2.03
4035	4 stage PISO shift register	1.15
4038	Triple serial register	1.75
4040	12 stage binary/ripple counter	.79
4041	Quad true complement buffer	1.17
4042	Quad clock D latch	.75
4043	Quad tri state NOR R/S latch	.82
4044	Quad tri state NAND R/A latch	.92
4046	Micropower phase locked loop	1.24
4047	Low power monostable/astable multivibrator	1.00
4049	Inverting hex buffer	.44
4050	Hex buffer	.53
4051	Single 8 channel multiplexer/demultiplexer	.75
4052	Dual 4 channel multiplexer	.75
4053	Triple 2 channel multiplexer/demultiplexer	.75
4054	4 segment display driver	1.75
4055	BCD to 7 segment recorder/LCD driver	1.75
4056	BCD to 7 segment recorder/LCD driver	1.75
4060	14 stage binary counter/oscillator	.82
4066	Quad bilateral switch	.47
4068	8 input NAND gate	.25
4069	Hex inverter	.25
4070	Quad 2 input XOR gate	.25
4071	Quad 2 input OR gate	.25
4072	Dual 4 input OR gate	.25
4073	Triple 3 input gate	.25
4075	Triple 3 input OR gate	.25
4076	4 bit D register	1.17
4078	8 input NOR gate	.33
4081	Quad 2 input AND gate	.25
4082	Dual 4 input AND gate	.25
4086	Expandable 4 by 2 AND/OR invert gate	.97
4093	Quad 2 input NAND Schmitt trigger	.50
4094	8 stage shift/store register	1.74
4097	Diff 8 channel analog mux/demux	2.30
4099	8 bit addressable latch	1.13
4501	Industrial control unit	.44
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4503	Hex tri state buffer	1.10
4504	Hex level shifter	2.00
4506	Dual Expandable AOI gate	1.37
4508	Dual 4 bit latch tri-state	2.07
4510	BCD up/down counter	.95
4511	BCD to 7 segment latch/decoder/driver	.95
4512	8 channel data separator	.80
4514	1 of 16 decoder/demultiplexer	1.90
4515	1 of 16 decoder/demultiplexer	1.90
4516	Binary up/down counter	1.10
4518	Dual BCD up counter	.75
4519	4 bit AND/OR select gate	.75
4520	Dual binary up counter	.90
4521	24 state frequency divider	2.59
4522	BCD divide by N counter	1.10
4526	4 bit binary divide by N counter	1.10
4527	BCD rate multiplier	1.10
4528	Dual retriggerable/resettable monostable	1.10
4529	Dual 4 channel mux	2.30
4530	Dual 5 input majority logic gate	1.65
4531	12 bit parity generator/checker	.96
4532	8 bit priority encoder	1.10
4534	Real time 5 decade counter	9.35
4536	Programmable timer	5.55
4538	Dual precision monostable multivibrator	1.75
4539	Dual 4 channel digital multiplexer	.95
4541	Quad 2 input analog mux	2.10
4543	BCD to 7 segment latch/decoder/driver	1.35
4553	3 digit BCD counter	5.05
4555	Dual binary 1 of 4 decoder	.90
4556	Dual binary 1 of 4 decoder	.90
4557	1-6 bit shift register	5.15
4558	BCD to 7 segment decoder	2.30
4560	NBCD adder	4.85
4561	9's complimenter	2.08
4562	128 bit static shift register	6.34
4556	Industrial time base generator	3.15
4568	Phase comparator/programmable counter	5.60
4572	Hex gate	.90
4573	Quad programmable op amp	3.43
4575	Quad programmable comparator	3.85
4580	4 x 4 multiport register	6.98
4581	4 bit A/U	5.05
4582	Carry look ahead generator	1.75
4583	Dual Schmitt trigger	2.18
4584	Hex Schmitt trigger	.67
4585	4 bit magnitude comparator	.97
4702	Programmable bit rate generator	9.95

Memories

For current pricing on memory check our ad each month in ETI

STATIC RAMS

2101	250nS 256x4	22 PIN	4.69
2102L	250nS 1Kx1	16 PIN	2.19
2114	450nX 1Kx4	18 PIN	1.49
2114L	200nS 1Kx4	18 PIN	2.59
2149-045	45nS 1Kx4	18 PIN	15.75
2016	150nS 2Kx8	24 PIN	9.95
6116	150nS 2Kx8 CMOS	24 PIN	10.95
6116L	150nS 2Kx8 CMOS	24 PIN	14.95

TTL PROMS listed in TTL above.

DYNAMIC RAMS

4116	200nS	1.95	16Kx1
4116	300nS	1.70	16Kx1
2118	200nS	7.85	16Kx1
2118	120nS	9.50	16Kx1
			SINGLE 5V SUPPLY
4164	200nS	8.95	64Kx1
4164	150nS	9.50	64Kx1
4164	120nS	12.00	64Kx1
41256	150nS	*	256Kx1

EPROMS ?

2708	1Kx8	450nS	8.00
2716	2Kx8	450nS	5.75
2716	2Kx8	350nS	7.50
2732	4Kx8	450nS	8.95
2732A	4Kx8	350nS	9.95
2532	4Kx8	450nS	9.95
2764	8Kx8	450nS	10.99
2564	8Kx8	450nS	28.95
27128	16Kx8	450nS	*

Exceltronix

Transistors

TRANSISTORS

DEVICE	PRICE	POL.		BVceo	Icmax	ft or Pdiss	hfe	CASE
2N697	.57	NPN	si	60V	1A	100 MHz	120 max	TO-5
2N706	.65	NPN	si	25V	200mA	400 MHz	60 max	TO-18
2N720	1.74	NPN	si	120V	1A	50 MHz	100 typ	TO-18
2N760	.70	NPN	si	45V	100mA	50 MHz	100 typ	TO-18
2N915		NPN	si	50V	———	250 MHz	250 max	TO-18
2N918	1.10	NPN	si	15V	50ma	500 MHz	40 max	TO-72
2N930	.45	NPN	si	45V	30ma	30 MHz	600 max	TO-18
2N964		PNP	Ge	7V	300ma	300 MHz	20 typ	TO-18
2N1040		PNP	Ge	50V	3A	20 W	200 max	TO-5
2N1303		PNP	Ge	25V	300ma	3 MHz	50 typ	TO-5
2N1304	3.30	NPN	Ge	25V	300ma	5 MHz	70 typ	TO-5
2N1379		PNP	Ge	25V	200ma	———	200 typ	TO-5
2N1893	.62	NPN	si	120V	500ma	50MHz	35 max	TO-5
2N2102	1.50	NPN	si	65V	1A	60 MHz	120 max	TO-5
2N2219A	.60	NPN	si	40V	800ma	250 MHz	300 max	TO-5
2N2221A	.34	NPN	si	40V	800ma	250 MHz	120 max	TO-18
2N2222A	.34	NPN	si	40V	800ma	300 MHz	300 max	TO-18
2N2239		NPN	si	40V	1A	———	30 min	TO-37
2N2270	.94	NPN	si	45V	1A	100 MHz	200 max	TO-5
2N2369A	.34	NPN	si	15V	200ma	500 MHz	120 max	TO-18
2N2428		PNP	G3	12V	100ma	1.2 MHz	130 max	TO-1
2N2432A		NPN	si	45V	100ma	20 MHz	50 min	TO-18
2N2483	.41	NPN	si	60V	50ma	60 MHz	120 max	TO-18
2N2484	.40	NPN	si	60V	50ma	60 MHz	500 max	TO-18
2N2614		PNP	Ge	40V	50ma	4 MHz	110 typ	TO-1
2N2641		NPN	si	45V	30ma	30 MHz	300 max	TO-99
2N2646	1.30	UJT	si	30V	2A	———	.75 max	TO-18
2N2647	1.38	UJT	si	30V	2A	———	.82 max	TO-18
2N2904	.59	PNP	si	40V	600ma	200 MHz	120 max	TO-5
2N2905	.60	PNP	si	40V	600ma	200 MHz	300 max	TO-5
2N2906	.34	PNP	si	40V	600ma	200 MHz	120 max	TO-18
2N2907A	.38	PNP	si	40V	600ma	200 MHz	300 max	TO-18
2N2920	4.98	NPN	si	60V	30ma	60 MHz	600 max	TO-99
2N2983		NPN	si	60V	700ma	60 MHz	250 max	TO-5
2N3014	1.66	NPN	si	20V	200ma	350 MHz	120 max	TO-52
2N3019	.75	NPN	si	80V	1A	100 MHz	300 max	TO-5
2N3053	.57	NPN	si	40V	700ma	100 MHz	250 max	TO-5
2N3054	1.54	NPN	si	55V	4A	25W	100 max	TO-66
2N3055	1.25	NPN	si	60V	15A	115W	70 max	TO-3
2N3117	.88	NPN	si	60V	50ma	60 MHz	900 max	TO-18
2N3227		NPN	si	20V	500ma	500 MHz	300 max	TO-18
2N3250	.43	PNP	si	40V	200ma	250 MHz	150 max	TO-18
2N3391A	.22	NPN	si	25V	100ma	90 MHz	375 typ	TO-98
2N3394	.48	NPN	si	25V	100ma	80 MHz	82 typ	TO-98
2N3415	.15	NPN	si	25V	500ma	———	360 typ	TO-98
2N3440	1.50	NPN	si	250V	1A	10W	80 typ	TO-5
2N3442	3.20	NPN	si	140V	10A	115W	38 typ	TO-3
2N3565	.57	NPN	si	25V	50ma	40 MHz	300 typ	TO-106
2N3566	.57	NPN	si	30V	50ma	40 MHz	300 typ	TO-105
2N3567	.57	NPN	si	40V	500ma	60 MHz	70 typ	TO-105
2N3568	.91	NPN	si	60V	500ma	60 MHz	70 typ	TO-105
2N3569	.61	NPN	si	40V	500ma	60 MHz	175 typ	TO-105
2N3638A	.57	PNP	si	25V	500ma	150 MHz	130 typ	TO-105
2N3641	.88	NPN	si	30V	500ma	150 MHz	70 typ	TO-105
2N3642	.59	NPN	si	45V	500ma	150 MHz	70 typ	TO-105
2N3643	,43	NPN	si	30V	500ma	250 MHz	140 typ	TO-105
2N3644	.63	PNP	si	45V	500ma	200 MHz	140 typ	TO-105
2N3645	.63	PNP	si	60V	500ma	200 MHz	140 typ	TO-105
2N3703	.17	PNP	si	30V	200ma	100 MHz	75 typ	TO-92
2N3704	.17	NPN	si	30V	800ma	100 MHz	300 max	TO-92
2N3705		NPN	si	30V	800ma	100 MHz	150 max	TO-92
2N3725	1.30	NPN	si	50V	1A	250 MHz	150 max	TO-5
2N3773	4.00	NPN	si	140V	30A	150W	30 typ	TO-3
2N3819	.60	N-JFET	si	25V	10ma	———	———	TO-92
2N3820	.69	P-JFET	si	20V	10ma	———	———	TO-92
2N3904	.22	NPN	si	40V	200ma	300 MHz	160 typ	TO-92
2N3905	.28	PNP	si	40V	200ma	200 MHz	100 typ	TO-92
2N3906	.22	PNP	si	40V	200ma	250 MHz	160 typ	TO-92
2N3947	.97	NPN	si	40V	200ma	300 MHz	160 typ	TO-18
2N4036	1.19	PNP	si	65V	1A	7W	76 typ	TO-5
2N4037	1.15	PNP	si	40V	1A	60 MHz	110 typ	TO-5
2N4062	.45	PNP	si	30V	30ma	———	170 typ	TO-92
2N4112		NPN	si	60V	5A	30W	140 typ	TO-3
2N4123	.20	NPN	si	30V	200ma	250 MHz	150 max	TO-92
2N4124	.20	NPN	si	25V	300ma	300 MHz	360 max	TO-92
2N4125	.20	PNP	si	30V	200ma	200 MHz	150 max	TO-92
2N4126	.20	PNP	si	25V	200ma	250 MHz	360 max	TO-92
2N4208	.85	PNP	si	12V	50ma	700 MHz	60 typ	TO-18
2N4222	2.24	N-JFET	si	30V	15ma	———	———	TO-72
2N4248	.75	PNP	si	40V	100ma	40 MHz	1000 max	TO-106
2N4250	.95	PNP	si	40V	100ma	50 MHz	800 max	TO-106
2N4339		N-JFET	si	50V	15ma	———	———	TO-18
2N4400	.22	NPN	si	40V	600ma	200 MHz	150 max	TO-92
2N4401	.22	NPN	si	40V	600ma	250 MHz	300 max	TO-92
2N4402	.22	PNP	si	40V	600ma	150 MHz	150 max	TO-92
2N4403	.22	PNP	si	40V	600ma	200 MHz	300 max	TO-92

TRANSISTORS

DEVICE	PRICE	POL.		BVceo	Icmax	ft or Pdiss	hfe	CASE
2N4416	1.75	N-JFET	si	30V	10ma	———	———	TO-72
2N4853		UJT	si	30V	50ma	———	———	TO-18
2N4856	2.30	N-JFET	si	40V	50ma	———	———	TO-18
2N4871	2.15	UJT	si	35V	1.5V	———	———	TO-92
2N4891	1.75	UJT	si	30V	1.0A	———	———	TO-92
2N5143	.40	PNP	si	20V	500ma	100 MHz	50 typ	TO-106
2N5172	.19	NPN	si	25V	100ma	120 MHz	500 max	TO-92
2N5195	2.83	PNP	si	80V	4A	40W	80 max	77-03
2N5210	.34	NPN	si	50V	50ma	30 MHz	600 max	TO-92
2N5232A	1.26	NPN	si	50V	100ma	———	375 typ	TO-98
2N5245	.67	N-JFET	si	30V	50ma	———	———	TO-92
2N5307	.77	NPN	si	40V	200ma	60 MHz	2000 min	TO-92
2N5356		PNP	si	25V	300ma	250 MHz	375 typ	TO-98
2N5369	.35	NPN	si	30V	500ma	250 MHz	175 typ	TO-92
2N5400	.25	PNP	si	120V	600ma	100 MHz	180 max	TO-92
2N5401	.30	PNP	si	150V	600ma	100 MHz	240 max	TO-92
2N5415	2.35	PNP	si	200V	1A	15 MHz	68 typ	TO-5
2N5447	.40	PNP	si	25V	200ma	500 MHz	300 max	TO-92
2N5457	.57	N-JFET	si	25V	10ma	———	———	TO-92
2N5458	.57	N-JFET	si	25V	10ma	———	———	TO-92
2N5459	.65	N-JFET	si	25V	10ma	———	———	TO-92
2N5485	.70	N-JFET	si	25V	10ma	———	———	TO-92
2N5525	1.74	NPN	si	40V	220ma	200 MHz	5000 min	TO-92
2N5550	.39	NPN	si	140V	600ma	100 MHz	250 max	TO-92
2N5770	.27	NPN	si	12V	50ma	900 MHz	40 min	TO-92
2N5771	.45	PNP	si	15V	50ma	850 MHz	35 min	TO-92
2N5772	.34	NPN	si	15V	300ma	350 MHz	30 min	TO-92
2N5881	3.94	NPN	si	60V	15A	160W	20 min	TO-3
2N5962	.37	NPN	si	45V	50ma	100 MHz	450 min	TO-92
2N6027	.43	PUT	si	40V	150ma	———	———	TO-92
2N6028	.43	PUT	si	40V	150ma	———	———	TO-92
2N6059	7.23	NPN	si	100V	12A	150W	18000 max	TO-3
2N6657	8.47	N-VFET	si	60V	2A	25W	———	TO-3
2N6658	10.00	N-VFET	si	90V	2A	25W	———	TO-3
MJ802	8.22	NPN	si	90V	30A	200W	100 max	TO-3
MJ2955		PNP	si	60V	15A	150W	70 max	TO-3
MJ3701		PNP	si	40V	1A	25W	100 max	TO-66
MJ4502		PNP	si	90V	30A	200W	100 max	TO-3
MJE340	1.76	NPN	si	300V	500ma	20W	240 max	77-03
MJE520		NPN	si	30V	3A	25W	25 min	77-03
MJE702		PNP	si	80V	4A	40W	750 min	77-03
MJE802		NPN	si	80V	4A	40W	750 min	77-03
MJE1093		PNP	si	80V	5A	70W	750 min	90-05
MJE1102		NPN	si	80V	5A	70W	750 min	90-05
MJE1103		NPN	si	80V	5A	70W	750 min	90-05
MPF102	.57	N-JFET	si	25V	10ma	———	———	TO-92
MPF105		N-JFET	si	25V	16ma	———	———	TO-92
MPS5172	.19	NPN	si	25V	100ma	120 MHz	500 max	TO-92
MPS6514	.17	NPN	si	25V	100ma	390 MHz	300 max	TO-92
MPS6515	.17	NPN	si	25V	100ma	390 MHz	300 max	TO-92
MPS6516	.18	NPN	si	40V	100ma	270 MHz	100 max	TO-92
MPS6519	.20	NPN	si	25V	100ma	420 MHz	500 max	TO-92
MPSA05	.17	NPN	si	60V	500ma	100 MHz	50 min	TO-92
MPSA06	.26	NPN	si	60V	500ma	100 MHz	50 min	TO-92
MPSA09	.17	NPN	si	50V	50ma	80 MHz	600 max	TO-92
MPSA13	.26	NPN	si	30V	500ma	125 MHz	10000 min	TO-92
MPSA14	.26	NPN	si	30V	500ma	125 MHz	20000 min	TO-92
MPSA18	.20	NPN	si	45V	200ma	100 MHz	1500 max	TO-92
MPSA20	.20	NPN	si	40V	100ma	125 MHz	400 typ	TO-92
MPSA42	.38	NPN	si	300V	500ma	50 MHz	40 min	TO-92
MPSA43	.38	NPN	si	200V	500ma	50 MHz	50 min	TO-92
MPSA55	.26	PNP	si	80V	500ma	100 MHz	50 min	TO-92
MPSA56	.32	PNP	si	80V	500ma	100 MHz	50 min	TO-92
MPSA65	.32	PNP	si	30V	300ma	175 MHz	20000 min	TO-92
MPSA70	.27	PNP	si	40V	100ma	125 MHz	400 typ	TO-92
MPSA92	.35	PNP	si	300V	500ma	50 MHz	25 min	TO-92
MPSU05		NPN	si	60V	2A	150 MHz	125 max	152-02
MPSU06		NPN	si	80V	2A	150 MHz	155 max	152-02
MPSU10		NPN	si	300V	500ma	60 MHz	25 min	152-02
MPSU51	.79	PNP	si	40V	2A	50 MHz	50 min	152-02
MPSU55	.82	NPN	si	60V	2A	100 MHz	160 typ	152-02
MPSU56	.85	NPN	si	80V	2A	100 MHz	160 typ	152-02
MPSU60	1.69	NPN	si	300V	500ma	60 MHz	25 min	152-02
PN2222A	.17	Electrically Equivalent to 2N2222A						
TIP29B	.69	NPN	si	80V	1A	30W	40 min	TO-220
TIP29C	.71	NPN	si	100V	1A	30W	40 min	TO-220
TIP30C	.70	PNP	si	100V	1A	30W	40 min	TO-220
TIP31C	.70	NPN	si	100V	3A	40W	25 min	TO-220
TIP32C	.75	PNP	si	100V	3A	40W	25 min	TO-200
TIP33C	1.54	PNP	si	100V	10A	80W	100 max	CP-3
TIP34C	1.80	PNP	si	100V	10A	80W	100 max	CP-3
TIP35C	2.92	NPN	si	100V	25A	125W	50 max	CP-3
TIP36C	3.07	PNP	si	100V	25A	125W	50 max	CP-3
TIP41C	1.01	NPN	si	100V	6A	65^2	75 max	TO-220
TIP42C	1.08	PNP	si	100V	6A	65W	75 max	TO-220

* Call us for price and availability.

Transistors

DEVICE	PRICE	POL.		BVceo	Icmax	ft or Pdiss	hfe	CASE
TIP47	.91	NPN	si	250V	1A	40W	25 min	TO-220
TIP48	.97	NPN	si	300V	1A	40W	25 min	TO-220
TIP49	1.02	NPN	si	350V	1A	40W	25 min	TO-220
TIP50	1.02	NPN	si	350V	1A	40W	25 min	TO-220
TIP110	.89	NPN	si	60V	2A	50W	500 min	TO-220
TIP111	.89	NPN	si	80V	2A	50W	500 min	TO-220
TIP115	.78	PNP	si	60V	2A	50W	500 min	TO-220
TIP120	.99	NPN	si	60V	5A	65W	1000 min	TO-220
TIP121	.99	NPN	si	80V	5A	65W	1000 min	TO-220
TIP122	1.01	NPN	si	100V	5A	65W	1000 min	TO-220
TIP125	.94	PNP	si	60V	5A	65W	1000 min	TO-220
TIP127	1.14	PNP	si	100V	5A	65W	1000 min	TO-220
TIP140	2.75	NPN	si	60V	10A	125W	500 min	CP-3
TIP141	2.99	NPN	si	80V	10A	125W	500 min	CP-3

DEVICE	PRICE	POL.		BVceo	Icmax	ft or Pdiss	hfe	CASE
TIP142	3.15	NPN	si	100V	10A	125W	500 min	CP-3
TIP146		PNP	si	80V	10A	125W	500 min	CP-3
TIP2955	1.26	PNP	si	60V	15A	90W	500 min	CP-3
TIP3055	1.15	NPN	si	60V	15A	90W	15 min	CP-3
TIS43		UJT	si	30V	50ma	———	———	TO-92
TIS58		N-JFET	si	25V	10ma	———	———	TO-92
TIS59		N-JFET	si	25V	10ma	———	———	TO-92
TIS62		NPN	si	12V	30ma	500 MHz	30 min	TO-92
TIS73		N-JFET	si	30V	50ma	———	———	TO-92
TIS74		N-JFET	si	30V	50ma	———	———	TO-92
TIS75		N-JFET	si	30V	50ma	———	———	TO-92
TIS84		NPN	si	30V	50ma	100 MHz	45 typ	TO-92
TIS86		NPN	si	30V	50ma	500 MHz	200 max	TO-92
TIS87		NPN	si	45V	50ma	500 MHz	150 max	TO-92

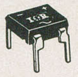
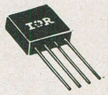
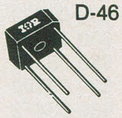
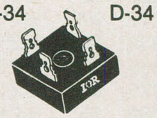
Zener Diodes

Vz VOLTS	½ Watt IN52XX	1.0 Watt IN47XX	5 Watt IN53XX
2.4	21		
2.5	22		
2.7	23		
2.8	24		
3.0	25		
3.3	26	28	33
3.6	27	29	34
3.9	28	30	35
4.3	29	31	36
4.7	30	32	37
5.1	31	33	38
5.6	32	34	39
6.0	33		40
6.2	34	35	41
6.8	35	36	42
7.5	36	37	43
8.2	37	38	44
8.7	38		45
9.1	39	39	46
10	40	40	47
11	41	41	48
12	42	42	49
13	43	43	50
14	44		51
15	45	44	52
16	46	45	53
17	47		54
	20¢	**25¢**	**$1.85**

Vz VOLTS	½ Watt IN52XX	1.0 Watt IN47XX	5 Watt IN53XX
18	48	46	55
19	49		56
20	50	47	57
22	51	48	58
24	52	49	59
25	53		60
27	54	50	61
28	55		62
30	56	51	63
33	57	52	64
36	58	53	65
39	59	54	66
43	60	55	67
47	61	56	68
51	62	57	69
56	63	58	70
60	64		71
62	65	59	72
68	66	60	73
75	67	61	74
82	68	62	75
87	69		76
91	70	63	77
100	71	64	78
110	72		79
120	73		80
	20¢	**25¢**	**$1.85**

Bridge Rectifiers

OUTPUT CURRENT	1.0A	2.0A	3.0A	6.0A	10.0A	25.0A
CASE STYLE	D-43	D-44	D-45	D-46	D-34	D-34

VOLTAGE	1.0A	2.0A	3.0A	6.0A	10.0A	25.0A
50	-----	2KBP005 $0.95	DBPC1005 $1.46	KBPC6005 $2.18	100JB05L $3.25	250JB06L $3.25
100	1DMB10 $0.60	-----	-----	-----	100JB1L $3.25	250JB1L $3.35
200	1DMB20 $0.65	2KBP02 $1.25	KBPC102 $1.55	KBPC602 $2.35	100JB2L $3.38	250JB2L $3.45
400	1DMB40 $0.69	2KBP04 $1.50	KBPC104 $1.70	KBPC604 $2.53	100JB4L $3.51	250JB4L $3.58
600	-----	2KBP06 $1.65	KBPC106 $1.87	KBPC606 $2.85	100JB6L $4.55	250JB6L $4.75

SCR'S, DIAC'S & TRIAC'S

SCR's

2N5061	800mA	60	TO-92	.67
2N5062	800mA	100	TO-92	.75
2N5063	800mA	150	TO-92	.79
2N5064	800mA	200	TO-92	.85
2N6333	2A	50	TO-39	1.97
2N6334	2A	100	TO-39	2.05
2N6335	2A	200	TO-39	2.31
2N6336	2A	300	TO-39	2.51
2N6337	2A	400	TO-39	2.73
TIC106B	5A	200	TO-220	0.79
TIC106D	5A	400	TO-220	0.85
TIC116B	8A	200	TO-220	1.59
TIC116D	8A	400	TO-220	1.65
TIC116M	8A	800	TO-220	3.66
TIC126B	12A	200	TO-220	1.75
TIC126D	12A	400	TO-220	2.25
TIC126M	12A	600	TO-220	3.68

DIACS

D3202Y	
D3202U	2A
	2A

TRIACS

PART #	Im	PIV	CASE	
TIC206B	3A	200	TO-220	1.38
TIC206D	3A	400	TO-220	1.47
TIC216B	6A	200	TO-220	1.69
TIC216D	6A	400	TO-220	1.75
TIC226B	8A	200	TO-220	1.64
TIC226D	8A	400	TO-220	1.69
TIC236B	12A	200	TO-220	1.76
TIC236D	12A	400	TO-220	1.82
TIC263B	25A	200		3.04
TIC263D	25A	400		3.96

Contact us for Quantity Pricing

Capacitors

CERAMIC PLATE CAPACITORS
100VDC

PART NUMBER	(pF)	TOLERANCE	PART NUMBER	(pF)	TOLERANCE
638 09188	1.8	± 0.25pF	638 58151	150	± 2%
638 09228	2.2	± 0.25pF	638 58181	180	± 2%
638 09278	2.7	± 0.25pF	638 58221	220	± 2%
638 09338	3.3	± 0.25pF	638 58271	270	± 2%
638 09398	3.9	± 0.25pF	638 58331	330	± 2%
638 09478	4.7	± 0.25pF	630 03391	390	± 10%
638 09568	5.6	± 0.25pF	630 03471	470	± 10%
638 09688	6.8	± 0.25pF	630 03561	560	± 10%
638 09828	8.2	± 0.25pF	630 03181	680	± 10%
638 10107	10	± 2%	630 03821	820	± 10%
638 10129	12	± 2%	630 03102	1000	± 10%
638 10159	15	± 2%	630 03122	1200	± 10%
638 10189	18	± 2%	630 03152	1500	± 10%
638 10229	22	± 2%	630 03182	1800	± 10%
638 10279	27	± 2%	630 03222	2200	± 10%
638 10339	33	± 2%	630 03272	2700	± 10%
638 10399	39	± 2%	630 03332	3300	± 10%
638 10479	47	± 2%	630 03392	3900	± 10%
638 10569	56	± 2•	630 03472	4700	± 10%
638 10689	*68*	± 2%	63 VOC		
638 10821	82	± 2%	629 03103	10 000	-20% +80%
638 10101	100	± 2%	629 03223	22 000	-20% +80%
638 10121	120	± 2%			

All Philips ceramic capacitors 12¢ each.

Disc Ceramic

CERAMIC DISK CAPACITORS (1000 VOLTS)
ALL VALUES IN PICO-FARADS

3.3	5	6	6.8	7.5	8
10	12	15	18	20	22
24	25	27	30	33	39
47	50	51	56	68	75
82	91	100	120	130	150
180	200	220	240	250	270
300	330	350	360	390	400
470	500	510	560	600	680
750	820	910	1000	1200	1300
1500	1600	1800	2000	2200	2500
2700	3000	3300	3800	4000	4300
4700	5000	5800	6800	7500	8200

All Values 9 cents each

VOLTAGE REGULATORS

POSITIVE

7805 + 5V 1A .... .75
78L05+ 5V .1A .... .43
78H05+ 5V 5A 9.44
78P05+ 5V 10A 14.97
7806 + 6V 1A .... .75
78L06+ 6V .1A .... .43
7812 + 12V 1A .... .75
78L12+ 12V .1A .... .43
78H12+ 12V 5A 10.95
7815 + 15V 1A .... .75
7824 + 24V 1A .... .75
78GUIC Adjust. 1A 1.33
78HGASC Adjust. 5A 11.47
78S40 Switching regulator 3.84

NEGATIVE:

7905 -5V 1A .... .85
79L055V .1A .... .75
7906 -6V 1A .... .85
7912 -12V 1A .... .85
79L1212V .1A .... .75
7915 -15V 1A .... .85
79GUIC Adjust. 1A 1.65
79HGASC Adjust 5A 17.99

Electrolytics

	16V	25V	35V	63V
.47uF				
1.0				.18
2.2				.18
3.3				.18
4.7	.13			
6.8			.18	
10.0		.13	.18	.20
15.0			.18	
22.0		.16		.27
33.		.16	.20	.35
47.0		.16	.21	
68				
100		.27	.24	.50
150	.48			
220		.41	.49	.74
330		.55	.58	.84
470	.45	1.02	.78	.88
680	.49		.78	
1000	.50	.78	.98	1.70
1500		1.08	1.16	2.10
2200	.99	1.1	1.30	2.98
3300		1.42	2.11	
4700	.99	2.11	2.69	

Please specify axial or radial leads when ordering

Tantalum Capacitors

DIPPED TANTALUM CAPACITORS

uF	WORKING VOLTAGE (V)					
	3	**6.3**	**10**	**16**	**25**	**35**
.1	—	—	—	—	—	.27
.15	—	—	—	—	—	.27
.22	—	—	—	—	—	.27
.33	—	—	—	—	—	.27
.47	—	—	—	—	—	.27
.68	—	—	—	—	—	.27
1.0	—	—	—	—	.27	.27
1.5	—	—	—	—	.27	.34
2.2	—	—	—	.27	.30	.37
3.3	—	—	.27	.30	.37	.41
4.7	—	.27	.30	.37	.41	.54
6.8	—	.30	.37	.40	.51	.60
10	.27	.34	.40	.51	.64	.78
15	.34	.40	.48	.52	1.10	1.73
22	.37	.48	.52	.71	1.50	2.17
33	.40	.53	.71	1.19	2.22	3.34
47	.48	.53	1.10	1.91	3.33	4.50
68	.58	.75	1.91	2.20	4.82	—

Resistors

5% TOLERANCE EIA STANDARD VALUES

Ohms	Ohms	Ohms	Ohms	Ohms	Ohms	Ohms	Ohms	Meg.
2.7	16	100	620	3.9K	24K	150K	910K	5.1
3	18	110	680	4.3K	27K	160K	Meg.	5.6
3.3	20	120	750	4.7K	30K	180K	1	6.2
3.6	22	130	820	5.1K	33K	200K	1.1	6.8
3.9	24	150	910	5.6K	36K	220K	1.2	7.5
4.3	27	160	1K	6.2K	39K	240K	1.3	8.2
4.7	30	180	1.1K	6.8K	43K	270K	1.5	9.1
5.1	33	200	1.2K	7.5K	47K	300K	1.6	10
5.6	36	220	1.3K	8.2K	51K	330K	1.8	11
6.2	39	240	1.5K	9.1K	56K	360K	2	12
6.8	43	270	1.6K	10K	62K	390K	2.2	13
7.5	47	300	1.8K	11K	68K	430K	2.4	15
8.2	51	330	2K	12K	75K	470K	2.7	16
9.1	56	360	2.2K	13K	82K	510K	3	18
10	62	390	2.4K	15K	91K	560K	3.3	20
11	68	430	2.7K	16K	100K	620K	3.6	22
12	75	470	3K	18K	110K	680K	3.9	—
13	82	510	3.3K	20K	120K	750K	4.3	—
15	91	560	3.6K	22K	130K	820K	4.7	—

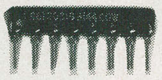
1% RESISTORS ARE AVAILABLE ON REQUEST

Prices

	IN STORE		MAIL ORDER	
	1-99	100-up	1-99	100-up
¼W	.03	.02	.06	.05
½W	.06	.05	.08	.06
1W	.10	.08	.15	.12
2W	.30	.27	.35	.30
5W	.35	.30	.40	.35
10W	.60	.50	.70	.60

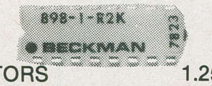
SIP (single in-line package)

PART #	PINS	COMMON PIN #	
6-1-XXX	6	1	**0.79**
8-1-XXX	8	1	**0.90**
10-1-XXX	10	1	**0.95**



XXX = Value

DUAL INLINE PACKAGE



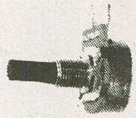
PART #	PINS	DESCRIPTION	
4114R-001-XXX	14	7 ISOLATED RESISTORS	1.25
4114R-002-XXX	14	13 RESISTORS, PIN 14 COMMON	1.25
4114R-003XXX	14	24 RESISTORS, DUAL TERMINATOR	1.25
4116R-001-XXX	16	8 ISOLATED RESISTORS	1.25
4116R-002-XXX	16	15 RESISTORS, PIN 16 COMMON	1.25
4116R-003XXX	16	28 RESISTORS, DUAL TERMINATOR	1.25

Potentiometers

Values Available

OHMS			
250	5.0K	50K	750K
500	7.5K	75K	1.0M
750	10K	100K	1.5M
1K	15K	150K	2.0M
1.5K	20K	200K	2.5M
2K	25K	250K	5.0M
2.5K	35K	500K	10M

All $1.25



Specify Linear or Log track.

Trim Pots

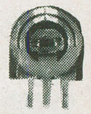
P.C. MOUNT MULTITURN TRIMPOTS
RESISTANCE

10	500	10K	200K
20	1K	20K	500K
50	2K	50K	1M
100	5K	100K	2M
200			

$1.65 ea.

TRIMPOTS
RESISTANCE

100	1000	10K	100K	1M
250	2500	25K	250K	2.5M
500	5000	50K	500K	5M



OPEN CASE 35¢
ENCLOSED CASE 85¢

Check our ads in ETI each month

The Exceltronix Bulletin Board

In addition to our electronic catalogue we will also shortly have in operation a number of computer bulletin boards (all operating on MULTIFLEX products) which can be accessed by the public. These bulletin boards will allow users to swap technical advice, software techniques, and public domain software. As well computer clubs are invited to use this bulletin board to leave information on their clubs, such as time and place of next meeting, cancellations, notice of special events, etc. MULTIFLEX owners may also wish to consult this board from time to time since a special file will be set up for machine language programs and subroutines which will run on the MULTIFLEX Z-80, U of T 6809 board and the new 68000/8086 computer. There will be no charge for the use of this system however maximum connect times may be established to allow a maximum number of users access to the system. When the system is running the phone numbers will be published in our ad in ETI.

Opto Couplers

TRANSISTOR OUTPUT	
MCT26	.96
4N28	.85
4N26	.85
MCT2	1.02
4N38	1.16
4N37	1.16
4N25	.85
4N27	.85
4N35	1.16
4N36	1.16

DARLINGTON OUTPUT	
4N31	1.16
4N29	1.13
4N30	1.13
4N32	1.16
4N33	1.16

TRIAC DRIVER OUTPUT	
MOC3011	1.81
MOC3020	1.37
MOC3030	2.04
MOC3031	2.68

SCR OUTPUT	
MOC3002	1.81
MOC3003	2.60

OPTO
TI ¾ Flashing LED .95

JUMBO LED

RED	.25
GREEN	.30
YELLOW	.35
ORANGE	.35

TI ¾

RECTANGULAR	.45
ROUNDED RECTANGULAR	.45

7 SEGMENT DISPLAYS	
DL1416	34.71
FND500	2.04
FND507	2.04
FND501	2.04
FND508	2.04
TIL313	1.85

10 ELEMENT LINEAR DISPLAY		
RBG - 1000	RED	4.50
OBG - 1000	HIGH EFFICIENCY RED	4.50
YBG - 1000	YELLOW	4.50
GBG - 1000	GREEN	4.50

All prices are in Canadian funds, Federal Tax included.

Switches

SWITCHES
MINIATURE TOGGLE

SOLDER TAIL PART#	PRICE	P.C. MOUNT PART#	PRICE	FUNCTION	ACTION
4030	2.50			SPST	ON-OFF
4031	2.70	4331	4.10	SPDT	ON-ON
4032	3.40	4332	3.80	SPDT	ON-OFF-ON
4033	4.10	4333	6.10	DPDT	ON-OFF-ON
4034	3.95	4334	5.50	DPDT	ON-ON
4231	2.90	4431	4.10	SPDT	ON-(ON)
4232	3.10	4432	4.15	SPDT	(ON)-OFF-(ON)
4233	4.50	4433	6.55	DPDT	(ON)-OFF-(ON)
4234	4.50	4434	6.55	DPDT	ON-(ON)
4235	3.50	4435	4.25	SPDT	ON-OFF-(ON)
4236	5.10	4436	6.85	DPDT	ON-OFF-(ON)

MINI-MINI TOGGLE SWITCHES

PART#	ACTION		
4050	SPST	1.90	RATED 3A
4051	SPDT	1.95	AT
4052	DPDT	2.20	125 VAC

DIP Switches

DIP SWITCHES
STANDARD AND RECESSED ROCKERS

NO. OF ROCKERS	SPST
1	—
2	—
3	—
4	$2.50
6	$3.00
8	$3.25
10	$3.50
12	—

TOGGLE SWITCH

NO. OF ROCKERS	SPST
1	—
2	—
3	—
4	—
6	$3.00
8	$3.25
10	$3.50
12	—

Crystals

MICROPROCESSOR QUARTZ CRYSTALS
HC-33/U CASE

1.000000 MHz	1.843200 MHz
2.000000 MHz	2.097152 MHz
2.457600 MHz	3.276800 MHz
3.579545 MHz	4.000000 MHz
4.194304 MHz	

HC-18/U CASE

1.000000 MHz	2.457600 MHz
3.276800 MHz	3.579500 MHz
4.000000 MHz	4.194304 MHz
4.915200 MHz	5.000000 MHz
5.017600 MHz	5.068800 MHz
5.120000 MHz	5.185000 MHz
5.714300 MHz	5.990400 MHz
6.000000 MHz	6.144000 MHz
6.400000 MHz	6.553600 MHz
8.000000 MHz	10.000000 MHz
10.240000 MHz	11.000000 MHz
11.674000 MHz	12.000000 MHz
14.318180 MHz	16.000000 MHz
18.000000 MHz	18.432000 MHz
20.000000 MHz	20.480000 MHz
22.118400 MHz	24.576000 MHz
28.356900 MHz	48.000000 MHz

REAL-TIME CLOCK CRYSTALS
32.768 kHz

All Crystals $5.30 each

Watch for our regular specials featured in our ads in ETI each month

Check our ads in ETI each month

Connectors

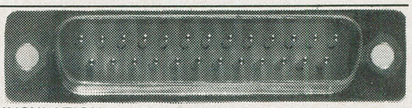
Pin Connectors (Dual Row Hooded Headers)

PINS	SOLDER TAIL STRAIGHT	MALE RIGHT ANGLE	WIRE WRAP STRAIGHT	MALE RIGHT ANGLE	RIBBON CABLE FEMALE
20	2.09	2.09	2.97	2.97	2.70
26	2.69	2.69	3.65	3.65	3.42
34	3.50	3.50	4.29	4.29	4.44
40	3.97	3.97	4.83	4.83	5.22
50	4.76	4.76	5.63	5.63	6.50
60	5.75	5.75	6.78	6.78	8.16

IC Sockets

	8	14	16	18	20	22	24	28	40
SOCKETS SOLDERTAIL	16¢	28¢	32¢	36¢	40¢	44¢	48¢	56¢	80¢
SOCKETS WIRE WRAP	65¢	89¢	1.11	1.17	1.49	1.69	1.75	1.89	1.98
LOW PROFILE MACHINE CONTACT	1.69	2.50	2.75	3.50	3.89	4.00	4.75	4.75	5.95
COMPONENTS PLATFORM	——	1.99	2.50	——	——	——	3.39	——	5.85
DIP HEADER	——	2.35	2.75	——	——	——	3.50	——	5.60

D-Shell Connectors



D—SHELL CONNECTORS

SUFFIX PINS	(XX-Z) PART#	RACK/PANEL CONNECTORS RP-P	RP-S	INSULATION DISPLACEMENT ID-P	ID-S	PRINTED CIRC. MOUNT PC-P	PC-S
9	DE-9-XX-Z	3.63	3.67	5.28	5.70	——	——
15	DE-15-XX-Z	4.95	4.95	7.12	7.68	——	6.85
25	DE-25-XX-Z	6.50	6.50	9.50	9.50	10.50	8.50
37	DE-37-XX-Z	6.95	11.00	12.35	13.48	——	——
50	DE-50-XX-Z	9.00	14.95	——	——	——	——

SUFFIX NOTES:
RP = STANDARD SOLDERTAIL
ID = RIBBON CABLE
PC = PRINTED CIRCUIT MOUNT (RIGHT ANGLE)
P = PLUG
S = SOCKET

D—SHELLS

PART#	
SH-9-X	3.75
SH-15-X	2.05
SH-25-X	2.05

Edge Card Connectors P.C. Mount

- 100 Contact Spacing

No of Contacts	
10	
50	4.00
86	8.68
100	5.75

- 125 Contact Spacing

No of Contacts	
20	3.36
36	4.72
50	6.16
60	7.15
86	9.66
100	10.85

- 156 Contact Spacing

No of Contacts	
20	6.65
22	7.15
50	8.19
86	13.30

THE EXCELTRONIX BULLETIN BOARD

In addition to our electronic catalogue we will also shortly have in operation a number of computer bulletin boards (all operating on MULTIFLEX products) which can be accessed by the public. These bulletin boards will allow users to swap technical advice, software techniques, and public domain software. As well computer clubs are invited to use this bulletin board to leave information on their clubs, such as time and place of next meeting, cancellations, notice of special events, etc. MULTIFLEX owners may also wish to consult this board from time to time since a special file will be set up for machine language programs and subroutines which will run on the MULTIFLEX Z-80, U of T 6809 board and the new 68000/8086 computer. There will be no charge for the use of this system however maximum connect times may be established to allow a maximum number of users access to the system. When the system is running the phone numbers will be published in our ad in ETI.

Store Hours
Mon-Wed 9.00-6.00
Thurs, Fri 9.00-9.00
Saturday 9.00-6.00

We carry a wide range of electronic and computer books including Sams, Tab, McGraw-Hill, Babani, Hayden, Osborne, Prentice-Hall, Sybex and Dilithium Press.

Monitors

BMC BM-12AU: $125
A 12" green phosphour monitor with a 12 MHz bandwidth, which is ideal for the APPLE computers (in either 40 or 80 column mode).

ZENITH ZVM-123: $139
A 12" green phosphour monitor with a 15 MHz bandwidth and a 40/80 column screen width selector switch works with just about any home microcomputer on the market today.

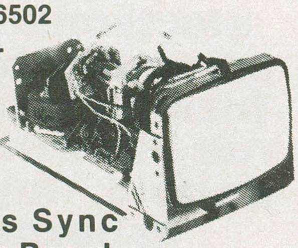
AMDEK COLOUR-1: $569
A 13", medium resolution, composite video colour monitor with a built-in speaker, which gives a great colour picture with just about any computer.

ZENITH AMBER ZVM-122: $219

AMDEK AMBER 300A: $269

5" Green Screen Monitors. $59

Open frame.
Requires 12V.
Ideal for 6502 computers.



Requires Sync Separator Board

Kit $9.95

Contact us for custom design and manufacture of computer products

Modems

HAYES SMARTMODEM: $399
This is an RS232C, 300 baud, direct connect, intelligent modem. It can answer calls, dial numbers, receive and transmit data and disconnect . . . all automatically. The SMARTMODEM is also a true direct connect modem - that means that it plugs directly into a modular telephone jack, not a specialized telephone. Thus much less noise and more reliable reception.

HAYES MICROMODEM II: $499
This unit has all the features of the Hayes SMARTMODEM, but on a single card which plugs directly into one of the expansion slots of an APPLE II/II+/IIe computer. It comes complete with software to allow you to use the modem as soon as you plug it in, or develop your own applications software.

NOVATION APPLE-CAT: $569
An intelligent modem which plugs right into your APPLE II/II+/IIe computer. All auto functions are supported, as well as an RS232 port. A BSR x10 controller, a telephone handset and an extra board to enable 1200 baud service are all options for this unit. It also comes complete with self-prompting software.

NOVATION AUTO-CAT: $399
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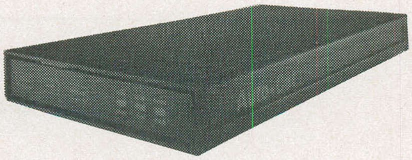

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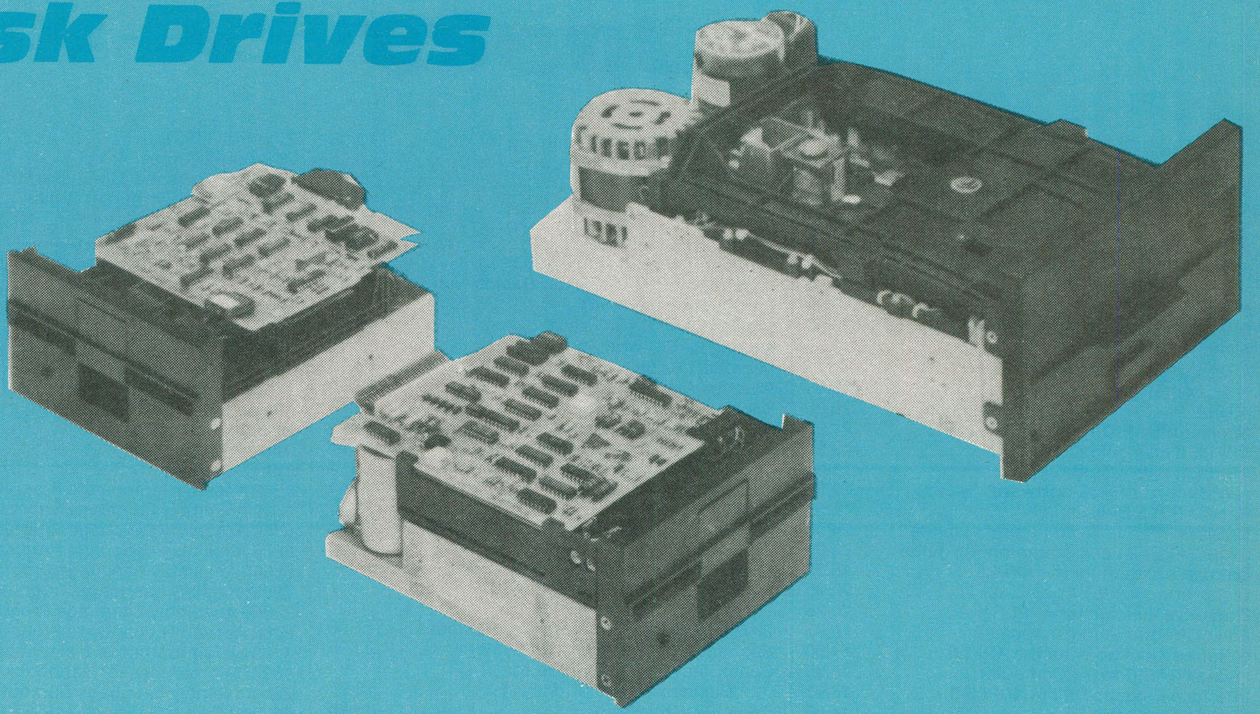

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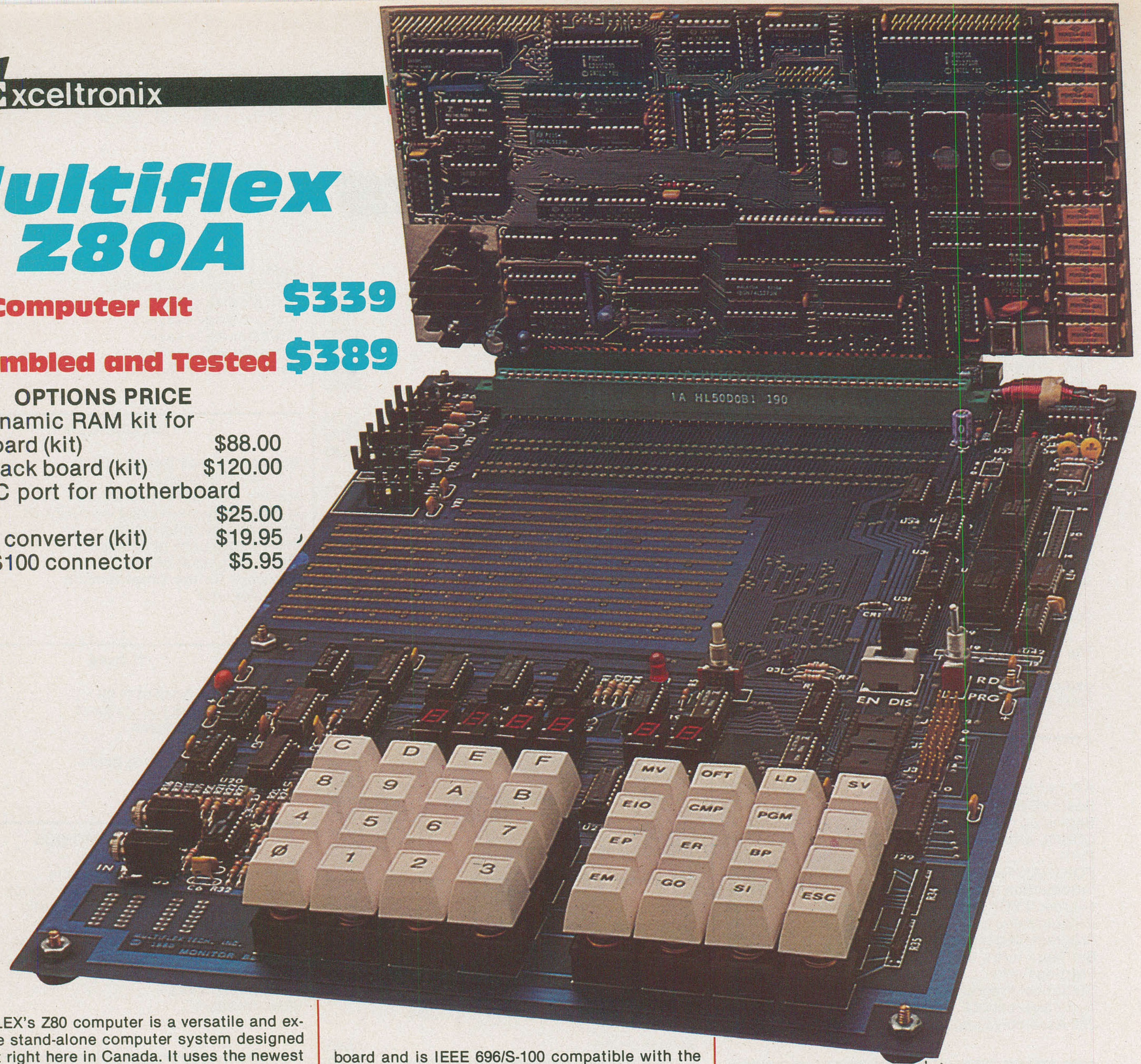

OPTIONS	PRICE
64K dynamic RAM kit for CPU board (kit)	$88.00
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RS232C port for motherboard (kit)	$25.00
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Extra S100 connector	$5.95

MULTIFLEX's Z80 computer is a versatile and expandable stand-alone computer system designed and built right here in Canada. It uses the newest technology to provide the user with the most capabilities for the smallest price-tag. Its adaptability to any situation and extremely low cost allow it to be used in many applications ranging from a trainer to a complete CP/M-based computer comparable to the best on the market, at a fraction of the price.

The actual layout of the system is a two board design. One board (the "motherboard") contains a 24-line parallel I/O chip for interfacing to the external world, an RS232C serial port with baud rates selectable from 110 to 9600 baud, a hex address and data display, a hex keypad, 14 monitor function keys, 2 user definable keys, a 40-chip wire wrap area with full access to all the bus signals, on-board provision for regulators so that the board can be supplied with standard S-100 voltages, an EPROM programmer which will handle 2708 (1Kx8), 2716 (2Kx8), 2732 (4Kx8) 2532 (4Kx8), 2764 (8Kx8) and the brand new 27128 (16Kx8) EPROMs, a DC-to-DC converter to supply the programming voltage to the EPROM programmer and four (4) slots for IEEE S-100 compatible boards for further expansion. This is an extremely useful and important feature as it allows expansion of the system with all boards using this industry-standard bus structure, which are available from MULTIFLEX, as well as from hundreds of manufacturers worldwide.

The other board is the CPU card. This card plugs into one of the S-100 slots on the motherboard and is IEEE 696/S-100 compatible with the full 24-bit address path to allow up to 16 megabytes of memory to be addressed. The processor used is the Z80 (running up to 6 MHz) and there is provision on-board for 64K of dynamic memory (using 4164 chips) which will operate without wait states. Provided for as well is a 2K to 32K (selectable in 2K blocks) common resident area in memory for use with multiple memory banks. There are also 4 sockets on board which will handle 2732 (4Kx8) or 2764 (8Kx8) EPROMs or the new 6116/2016 (2Kx8) static RAMs (all of which can be software deselected if desired) to allow the user complete versatility in setting up the board to meet his own specifications. Also on board is 1 parallel port with 24 lines of I/O and 3 16-bit counter/timers for applications which require the unit to keep track of real time. Another feature of the CPU board is that it was designed by our engineers to run the CP/M 2.2 disk operating system so that if a floppy disk controller board is added to the system a fully configured CP/M machine can be set up for a very low cost as described on page 13.

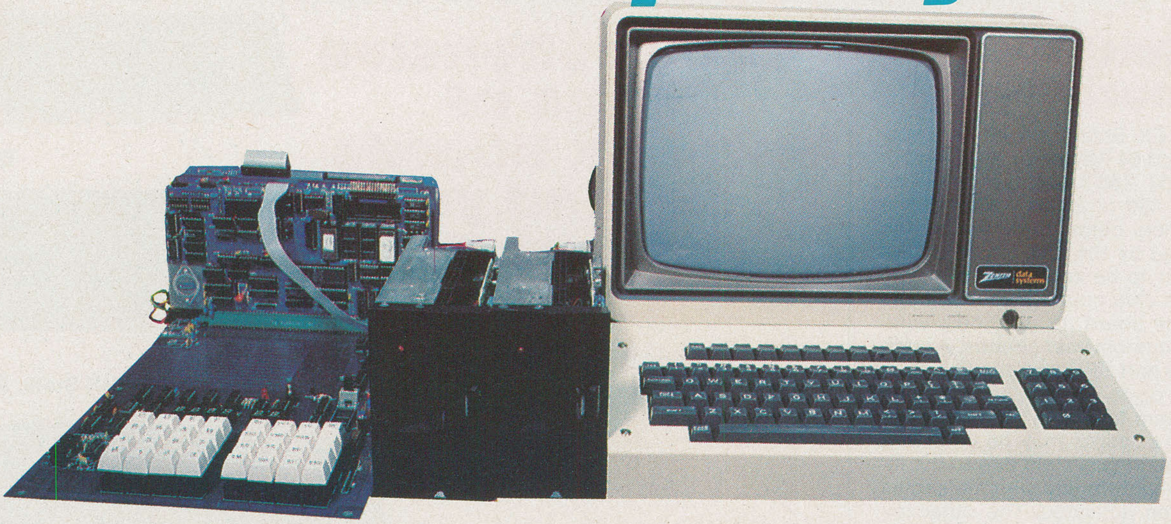
The monitor software that comes with the kit is a well-written extensive package which allows the user to have complete versatility in machine language programming and execution as well as control of all the features on the board. The monitor functions include: examine/modify memory locations, memory block moves, compare 2 blocks of memory, examine CPU registers, examine I/O ports, load and save from cassette, calculate relative branch offsets, set breakpoints, single step programs, execute programs, and program EPROMs. Each of these processes is invoked by a single keypress. Also available to the user are 2 spare keys definable for special functions as required by specific applications and application programs.

Available as an option, there is a piggyback board which attaches to the CPU board and gives the user a real-time/time-of-day clock with battery back-up, memory management for up to 16M of memory in 4K blocks, 2 RS232C ports which have independent software selectable baud rates, vectored interrupts for the onboard I/O and clock devices, and a general interrupt controller designed to handle multiple interrupts for up to 7 other boards.

All these features make this a very impressive stand-alone unit and, when combined with other S-100 boards either from the MULTIFLEX line or from most other manufacturers, give the user the potential for a very powerful microcomputer system.

The standard kit includes the CPU board with a Z80A (4HMz) processor, 2K of RAM (a 6116), and 4K of EPROM (a 2732) as well as the motherboard with all the features mentioned above except the RS232C port and the DC-to-DC converter. Also supplied are sockets for all IC's and 1 S-100 connector.

Multiflex Super System



All this for an incredible $1195 *

Nowhere in Canada, can you find a computer value such as this one. The **MULTIFLEX Super System** is the ideal computer for the person who wants to get the most for his system dollar.

The package consists of: the **MULTIFLEX Z80 Computer Kit** c/w 64K of dynamic RAM, the **MULTIFLEX Economy Video Board,** the **MULTIFLEX Floppy Disk Controller Board,** 1 5 ¼" disk drive (either a SA400L or an SA200), and CP/M complete with the **MULTIFLEX BIOS.** All of this makes a fully expandable CP/M-based IEEE 696/S-100 system, that is on par with any on the market, but which costs much, much less.

The **MULTIFLEX Z80 Computer Kit** is the heart of this powerful system. Its special features include an EPROM programmer (which will handle any EPROM from a 2716 up to a 27128), 4 S-100 slots, a 40-chip wire-wrap area, 2 built-in parallel ports, up to 3 optional RS232 ports. a hex keypad, 16 function keys, a hex address/data display, a Z80 processor (and which can run at 4 MHz), 64K of dynamic RAM, optional memory management, an optional real-time clock, and room for up to four IEEE 696/S-100 cards.

The **MULTIFLEX Economy Video Board** gives the user an 80 character display on a standard composite video monitor. The board emulates a standard terminal, which allows the user to configure his software to run extremely easy on his system. A number of attributes, such as inverse video, highlighting, underlining, and blinking characters. There is enough on-board RAM to allow for up to 3 ½ pages of text to be stored on the board, making local editing a breeze. A keyboard also contained on the board for easy interfacing of just about any ASCII keyboard.

The **MULTIFLEX Floppy Disk Controller Board** is a full featured floppy disk controller board. It allows use of 8" or 5¼" drives, whether they be single or double density or single or double sided, in any combination (up to a maximum of 4 drives total). The board is based on the WD2793 disk controller IC and the FDC9216B integrated disk data separator IC, which makes this board extremely reliable and versatile.

The other items in the package include a 5¼" single-sided, double-density disk drive (either an SA400L or an SA200) and the CP/M 2.2 operating system complete with the **MULTIFLEX BIOS.** This BIOS allows the user to mix and match his disk drives and even read (or write) the OSBORNE 5¼" disk format, which gives the user a more extensive selection of software.

The **MULTIFLEX Super System** is ideal for the computer enthusiast, hobbiest, educational institutions or the serious computer user who is looking for a low-cost way to enter the world of CP/M computing, with an expandable and versatile system.

* BASIC EXTRA OPTIONS

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Keyboard (without numeric keypad) . $99
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Power Supply (5V 6A, +15 3.7A, -15V 3.7A) includes case and RF filter. Ideal for this system. $139
Zenith 12" Green Monitor (10% off this price if purchased with system) $139

Huge Selection of Options Available

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1. Piggyback board with 2 serial ports and real time clock (kit) $120.00
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5. DC-DC convertor for programming EPROMs $19.95

Plus Many More — Runs Virtually all S-100 Cards.

Software

1. BASIC (running under CP/M)
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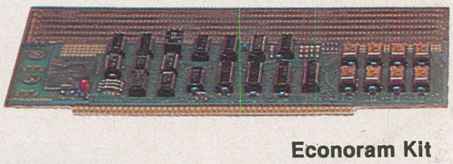
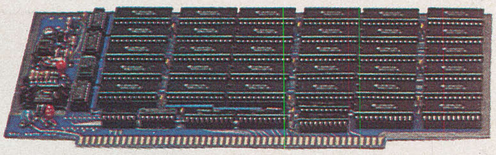
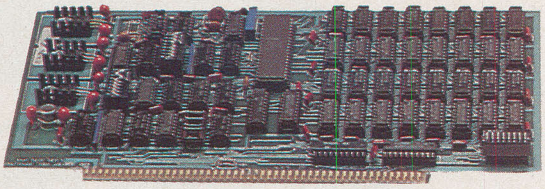


Econoram Kit



64K Static RAM Card Kit



RAM 1 Kit

Multiflex Econoram Kit

The MULTIFLEX Econoram kit is a low cost way to add 64 Kbytes of RAM to your IEEE 696/S-100 Z80-based system. The board uses 8 150 or 200ns 4164 64K x 1 dynamic memory chips, refreshed by the signal supplied by the Z80, which allows the chip count to be kept to an amazing 25!! Since the chip count is so low, there is room on the board for a 28 chip wire-wrap area for custom user circuits. A latch address at I/O port FFH (supplied on each board) allows up to 16 such boards to be used in a system for a total of 1 Mbyte of memory. These boards may be used in a memory-mapped I/O system due to the inclusion of a phantom line which disables the board when activated. The other important feature of the board is that it requires only a +8V (jumperable to +5 if your power supply is already regulated) power supply. This board is superb for the person who wants to add extra memory, but doesn't want to spend extra money.

Kit $179
A&T $250

Remember, we maintain a professional service staff

Multiflex 64K/Static RAM Card Kit

This is one of the new high technology boards in the MULTIFLEX line of IEEE 696/S-100 compatible computer board kits. Using the new 2K x 8 static RAM chips, the user can have 64K worth of RAM in his system without having to worry about the timing problems caused by refreshing. In the standard kit the user is supplied with CMOS 6116 chips so that with the optional battery backup circuit, memory can be retained up to one year after a power down situation occurs. Other features include a deselect feature for each 2K chip (in the range C000H to FFFFH) so that the RAM card does not conflict with system EPROMs and the fact that any RAM chip can be replaced by a standard 2716 EPROM. A battery charger circuit is provided for the batteries used in the power down back-up circuit. Also, the board may be disabled during memory-mapped I/O operations by use of the S-100 "phantom" signal. This board is a very inexpensive way to add 64K worth of RAM to your S-100 system.

Kit with 16K $249
Kit with 32K $319
Kit with 64K $395
A&T with 64K $459

Multiflex RAM 1 Kit

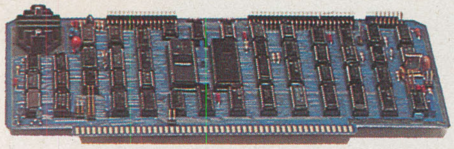
The RAM 1 kit from MULTIFLEX is the first in a series of IEEE 696/S-100 RAM cards. Based on the 8202 Dynamic Memory Controller chip, which minimizes wait states and allows on-board refresh, each board can hold up to a maximum of 64K bytes of 200nS 4116 memory chips (ie. 32 chips). The board has a software bank-select feature allowing up to eight (8) full boards to be used in a single system. If the user uses a slightly modified addressing scheme, any microprocessor can access up to 512 Kbytes of memory. To maximze flexibility, hardware jumpers are used to select certain functions on the board, allowing for variations in user applications. Firstly, the refreshing of the memory chips may be done internally by the 8202 (this is transparent to the system) or externally if the proper signals are available from some other board in the system. Secondly, the memory map on the board may be defined in 16K blocks by use of jumpers. This feature is used mainly with partially populated boards, however it may also be used as a limited write protect feature. As with all other boards in the MULTIFLEX line, the S-100 bus is fully buffered. All these features make this board an excellent way to add more memory to your S-100 system.

Kit with 16K $295
Kit with 64K $350
A&T with 64K $450

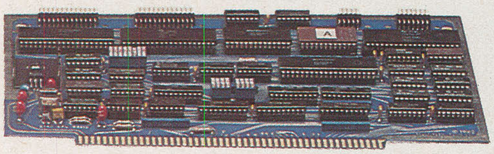
Multiflex Economy Video Board

This is yet another of the exciting new IEEE 696/S-100 compatible products from MULTIFLEX Tech. Inc. This board is an intelligent, I/O mapped, 80 x 24 Video Display Board. Based on the 8275 programmable CRT controller, the 8257 programmable DMA controller, and a Z80 processor, this board has many extremely useful features that are extremely simple for the user to implement. Provided on board is 8K of static RAM which gives the user 3½ screens of text. With simple commands, the user can easily scroll around in this buffer, clear the present page and home, home on the present page and go to the beginning of the buffer. There are also 4 field attributes (blink, reverse video, underline, and highlight) which can be turned on and off by software. Other software commands include a carriage return, line feed, clear to end of line; transmit cursor location; transmit character at cursor location; position cursor; disable control functions; reset control register; as well as all the standard functions such as tab return, line feed, and backspace. Also included in the software is a debug/setup program which completely tests the board and allows the user to set up various parameters on it. The output from the board is in either composite video or a video signal with separate horizontal and vertical sync signals (either normal or inverted). All this makes this board a superb value in an S-100 video board.

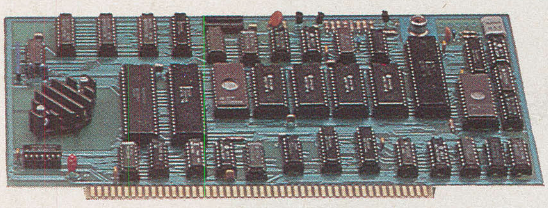
Kit $295
A&T $349



Floppy Disk Controller Kit



Zilog CPU Card Kit



Economy Video Board

Zilog CPU Card Kit

MULTIFLEX is pleased to announce its new IEEE 696/S-100 based processor card kit using the ZILOG series of processors and support chips. The Z80 processor can be jumper selected to run at 2 or 4 MHz. Also selectable, on 4K boundaries is the reset/power-on jump. There are 2 Z80-PIO parallel port chips on board which provide 32 fully programmable I/O lines. One (1) RS232 port and 1 TTL-level serial port are also provided for by use of a Z80-DART integrated circuit. If the user wishes to have syncronous serial data transfer, he can simply replace the Z80-DART with a Z80-SIO/0 and he will have all the standard features of the DART along with syncronous data transfer. There is no RAM provided for on-board, however there is a space for an EPROM which can be selected to be either a 2716 (2K x 8) or a 2732 (4K x 8). Also, the board takes full advantage of Z80 vectored interrupts and priority arbitration.

Kit $275
A&T $350

With every Multiflex Kit you get 2 hours free service.

Multiflex Floppy Disk Controller Kit

The MULTIFLEX floppy disk controller is a state-of-the-art IEEE 696/S-100 compatible board. It allows the user to interface, simultaneously, up to four (4) 8 inch or 5¼ inch disk drives in any combination to his system with the flexibility of single/double sided and single/double density operation. If desired, all operations can be done using DMA techniques with the optional on-board controller or under processor control. Latest technology has been used in this design. The board is designed around the FD2793 controller chip for easy use under any operating system. However, this board is especially designed for easy use with the CP/M or MP/M operating system (available as an option) and the MULTIFLEX Z80 computer kit. With all these features and its reasonable cost, this board is one of the best buys in a floppy disk controller board on the market today.

Kit $295. A&T $350
DMA Kit $29.00
CP/M (with BIOS) $169

MULTIFLEX VIDEO CHARACTER BOARD Kit:

The MULTIFLEX Video Character Display Board is the first in a line of IEEE 696/S-100 compatible video display boards. With its own Z80 microprocessor and 6845 CRT controller, this board uses only 2 I/O ports with full handshaking and interrupt capability. There are 12 Kbytes of on-board RAM for screen buffering, with bus arbitration built in. This means that the on-board processor can access the screen RAM at any time without interfering with the display (or without encountering wait states), which make extremely rapid screen updates possible. There is provision for up to 16K of program EPROM (using a 27128), so the user can customize his software to his requirements. A standard keyboard connector is furnished for addition of an ASCII keyboard. A 4K EPROM character generator containing 128 ASCII symbols and 128 block graphic symbols is one of the standard features of the board. As well, a 4K RAM bank is set aside for the user to program up to 256 custom characters and symbols in software. This allows a choice of up to 512 displayable characters to be in the system (and on the screen) at any one time. Four displayable attritibutes are available to be used in any combination for any character on the screen. These are inverse video, blinking video, underlined and a 4 bit grey-scale which will give either bright or dim characters. The 4-bit grey-scale can be turned into colour if the optional piggyback board (described later) is added.

This board was developed to give the maximum flexibility so the user can meet his display requirements. To this end, there are numerous software selectable features. There are four selectable modes for screen display, which are 24 lines of 80 characters, 48 lines (interlaced) of 80 characters, 24 lines of 132 characters, or 48 lines (interlaced) of 132 characters. Also selectable is the character size. It can either be 5 x 7 pixels in a 6 x 10 block or 7 x 9 in an 8 x 12 block.

On a board with these superb text handling capabilities, one would not expect bit-map graphics. The MULTIFLEX Video Character Display does have that capability! The user can software select one of three modes: 320 x 240 pixels in 1 bit-plane; 256 x 192 pixels in 2 bit-planes; or 176 x 132 in 4 bit planes. Each bit-plane oan either be used as part of a grey-scale (ie intensity, or colour select if the user has the piggyback board option) or as a separate screen of single intensity bit-map graphics.

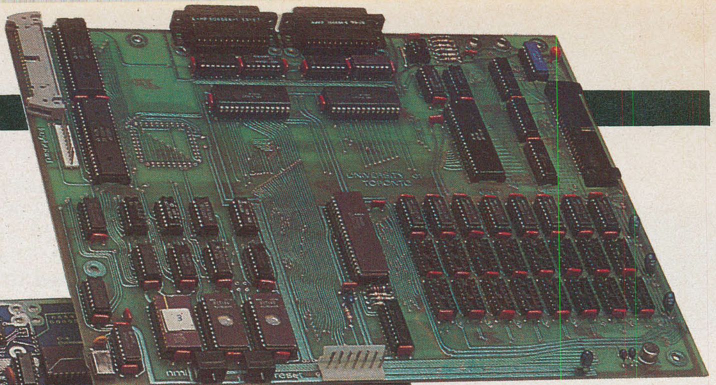
Available as an option for the board is a piggyback board which gives the user some enhanced features over the standard unit. 2K of RAM is located on this board for the user to add his own custom subroutines to the software included in the board. This RAM can be loaded directly from the S-100 bus. Another 2K is available for use in a print spooler buffer which will allow the main processor in the system to perform more of the functions it was designed for and not be tied up doing mundane I/O chores. this print spool area is connected to a standard Centronics-type parallel printer port. Three (3) 16-bit counter-timers provide software selectable baud rates for a complete RS232C serial interface (which also includes extension connector), as well as real-time clock interrupts. When the piggyback board is added to the Video Display Board, colour then becomes available to the user. On the piggyback board are 16 12-bit registers which allow the user to software select 16 colours from the 4096 possible colours. An RGB colour monitor and NTSC-encoded UHF RF-modulator output are both provided for attachment of different monitors or even an unmodified TV. A light pen option is also built onto the board and this as well as all other devices have interrupt capability in the system.

All these features! But that is still not all! The MULTIFLEX Video Character Display Board also can be used as a stand-alone intelligent terminal with default set up parameters, set up by jumpers. The board can also be used as a terminal emulator in an IEEE 696/S-100 system with complete control commands and local editing. That's just one more thing which adds up to show that the MULTIFLEX Video Character Display Board is one of the best on the market, especially in its price range.

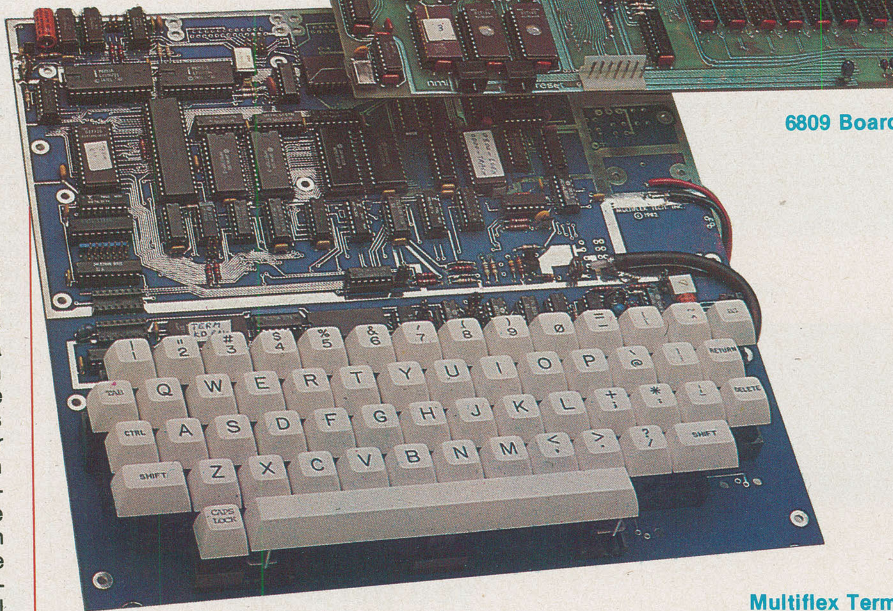
Main Board Kit $295
Piggyback Board Kit $195
Both A&T $649

Exceltronix

Multiflex Products



6809 Board



Multiflex Terminal

Multiflex Economy Video Display Terminal Kit

Now available from MULTIFLEX is an economy video display terminal. Originally designed as a low cost access unit for our soon to be operational computerized mail-ordering and bulletin board system, this terminal is a semi-intelligent system which is controlled by a Z80A microprocessor and a 6845 CRT controller chip. The keyboard is fully ASCII encoded and the character generator contains the full 128-character set as well as a 128-character alternate set both of which are in the 5x7 dot matrix format. The screen display is 80 characters by 24 lines if the unit is hooked to an external monitor (not included) or 64 by 24 if run through an RF modulator to a TV. There are 3 software selectable attributes (dim, reverse video, and alternate character set) which can be chosen one at a time for the whole screen. This attribute can then be switched on and off for each individual character. A 2K buffer is provided for normal operation. However when the optional 6K memory upgrade is purchased, 4 screen pages can be loaded from the host machine, edited localy, and then downloaded back to the host again saving on connect time and phone line bills. Also included are 2 RS232 ports: one for a modem and one so that a printer can be attached to the terminal. The baud rates on these ports are software programmable and can range from 110 to 9600 baud. The MULTIFLEX Video Display Terminal has provision for an on board modem freeing a serial port. With all these features, you would expect to pay a lot for this kit, but all this is available to you, complete with a case, for an extremely low price.

Kit $259
Kit & Case $289
A&T plus case $369

U of T 6809 Single Board Computer

The 6809 Single Board Computer, designed at the University of Toronto and distributed exclusively by EXCELTRONIX, is a compact hardware unit which was designed originally as a lab board for teaching students about microprocessor systems. Its many features, however, make it an ideal unit for stand-alone control applications or software development systems as well.

The system is designed around the Motorola MC6809 microprocessor. This is an 8-bit processor with full 16-bit internal architecture, 2 index registers, 2 stack pointers, 2 8-bit or 1 16-bit accumulators, a direct page register and a wide range of addressing modes, including a program-counter-relative mode. This mode allows the user to write completely position independent software, important in systems software development.

There is provision for up to 48K bytes of dynamic RAM on-board. The refreshing of this RAM is controlled by an 8202 Dynamic RAM Controller. This chip allows for completely transparant refreshing of the RAM (ie. no wait states to slow the system down). There is also provision for up to 12K of EPROM using either 2532 or 2716 chips.

There are 4 complete I/O circuits built onto the board. 2 of them are serial (RS232); one is used for a terminal (which is required for use of the board with the supplied monitor software), and the other one is user defineable, but it is set up to communicate with either a modem or a printer. Also on-board are 2 6522 VIA chips. These provide 2 parallel ports per chip along with 2 16-bit timer/counters. One of the parallel ports and one of the timers are use by the monitor software to provide a cassette interface (which operates at 300 baud). The second parallel port on that chip is wired into a connector which is ideal for interfacing a parallel printer or keyboard. The 2nd VIA is not used at all and is completely free for the user. For further expansion of the system, a fully buffered version of the CPU signals (data, address, control lines and a signal indicating whether or not the current address is located on the board) is available at a cable connector.

The software provided with the system is in a 2532 EPROM and allows the user to: test the memory; dump blocks of memory; examine and modify single memory locations; read or write from the cassette port; set and examine breakpoints; single step and/or execute machine language programs and set and examine the processor registers. All this is accomplished through a 9600-baud terminal interface (one of the serial ports) Included is a full screen editor/assembler which allows the user to work in 6809 assembly language rather than machine language. All this makes this board an ideal trainer, control unit or software development unit for just about anyone.

Kit with 16K $369
A&T with 48K $499

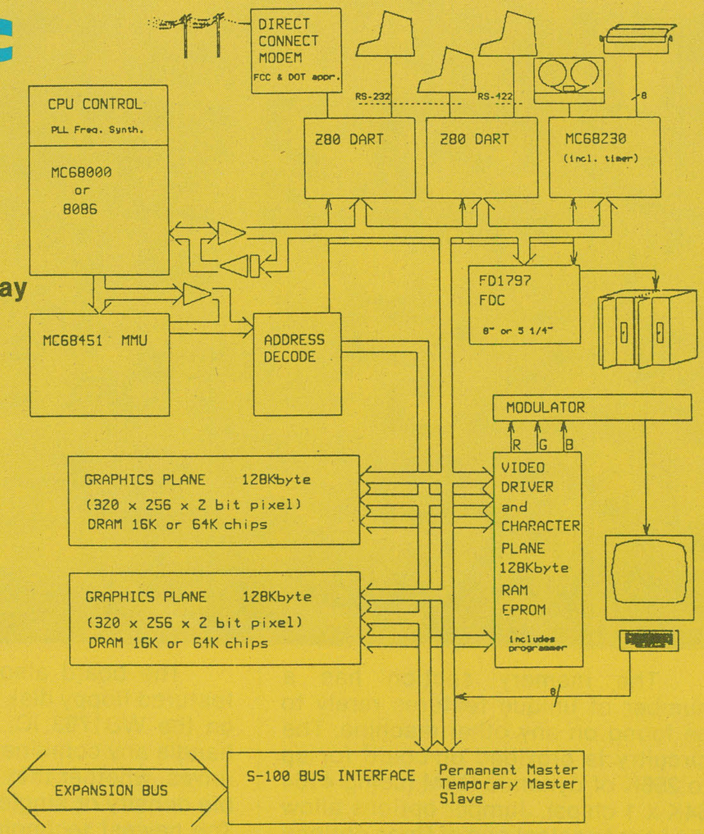
Special Pricing is available when both items on this page are purchased together

Multiflex 68000 System

FEATURES:
*Works with either of the two major 16-bit microprocessors: the MC68000 or the 8086.
*Speed from 2-12 MHz.
*Maximum of 16M bytes of memory.
*4 serial ports on-board.
*24-bit counter/timer on-board.
*Centronics printer interface.
*Cassette interface.
*Full floppy disk controller.
*82x25 text display.
*320x256 pixel, 4 colour graphics.
*RGB or composite monitor interface.
*Various operating systems available (CP/M-86, XENIX, MS-DOS).

Basic Kit $695

Price and specification may change without notice.



The **MULTIFLEX** 68000/8086 Single Board Computer allows the user to enter the exciting new world of 16-bit computing at an impressively low price, with the option of making his system very powerful very easily.

The most important feature of this system is the processor, or rather the choice of processors. There is a choice of two: a Motorola MC68000 or the Intel 8086. Both of these processors run at speeds ranging from 2 - 12 MHz. This choice allows the user to pick the processor to fit his specific needs.

The 68000 is Motorola's venture into the world of 16-bit microprocessors. The 17 internal registers are divided into two groups; a group of 8 32-bit data registers (which can be used in 8, 16 or 32 bit segments) and a group of 7 address registers and 2 stack pointers. There are two stack pointers so that the system software and user's software can maintain separate stack and not interfere with one another. A separate 16-bit data path and 24-bit address path are built into the 68000, so that no external de-multiplexing is necessary, which help keep the throughput of the processor high. This allows this microprocessor to be used in a multitasking or high-level language environment with great ease.

The 8086 microprocessor is an upwards-compatible member of the 8080 series of microprocessors. This means that there is software compatibility (at the source code level) between this 16-bit unit and the earlier 8-bit microcomputers. The register layout of this machine is similar to the 8080, but the registers are 16-bits wide instead of 8-bits. Directly, with its multiplexed address/data bus, the 8086 can address up to 1 Mbyte of memory.

The basic system comes with a comprehensive 68000 monitor in EPROM which creates an ideal basis for the user, who wants to learn how to use a 16 bit system and who wants to eventually expand it.

A full 16 Mbytes of memory can be addressed by the combination of the processor and the 68451 Memory Management Unit. Of this memory, there are 7 sockets (each of 16K bytes size) which can be set up for either RAM or EPROMs. Also 5 of these sockets can be strapped to program EPROMs. The maximum on-board RAM is 300K bytes. The fully extended S-100/IEEE 696 bus on the board allows for another 15M bytes worth of memory. All of this memory give the user complete flexibility for whatever application he has in mind.

This board also has an amazing assortment of I/O features. Four serial ports are included on the board, each with individually programmable baud rates. Two of these ports are setup with RS232 drivers, one with a RS422 driver, and one is set up for an optional onboard direct connect modem. Also onboard is a parallel port controller that is wired up as a Centronics-type printer port and also handles a cassette interface. A 24-bit programmable timer is also included so that user timing functions (such as a real time clock) can be set up. Also included on-board is a full-featured floppy disk controller. This controller will handle up to 4 drives (either 8" or 5¼") in either double density or single density modes with either double or single density drives.

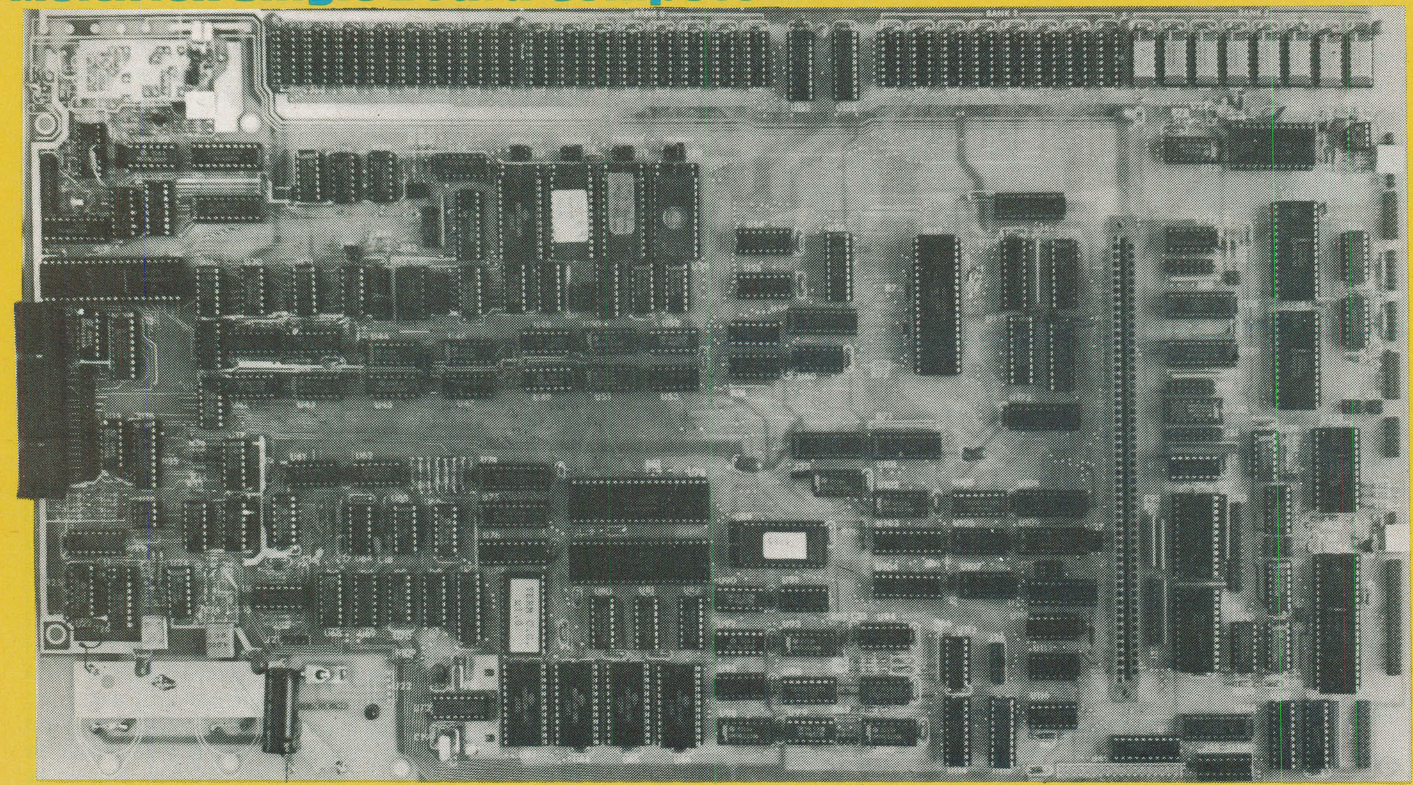
The video section on the **MULTIFLEX** 68000/8086 Single Board Computer is another very impressive feature of this system. An RGB monitor, a composite video monitor, and an RF modulator are all provided on-board. For text display, the user gets an 82 character by 25 line screen (41 x 25 through the RF modulator). All characters on this display can have up to 4 attributes (Inverse video, Highlight, Underline, and Blink) and each character be in one of 4 colours. The character generator for all characters is in RAM, so that user defined characters are a breeze to create and use. Also supported are full 4-colour graphics with a 320 x 256 pixel resolution. There is anASCII parallel keyboard interface on the board as well.

All of these features make the **MULTIFLEX** 68000/8086 Single Board Computer Canada's leader in the new 16-bit computer technology.

Multiflex Products

Multiflex Single Board Computer

Kit with 64K $599
A&T with 64K $795
CP/M (with BIOS) $169



FEATURES:
*Full IEEE S-100 bus for easy expansion.
*Up to 256K of on-board dynamic RAM.
*Processor speed 4 MHz.
*Memory management for up to 16M bytes of memory.
*3 16 bit timer/counters.
*2 RS232C serial ports.
*24 line parallel port.
*Real time (time-of-day) clock.
*Floppy disk controller.
*80x24 video display.
*512x512 bit-map graphics
*Print spooler.
*Optional RF modulator.
*Priority interrupts.
*Fully CP/M compatible.
*Many jumper-selectable hardware options.

The MULTIFLEX Single Board Computer is among the new breed of state-of-the-art Canadian computer products. With a Z80 series microprocessor, 64K of dynamic RAM, a full featured floppy disk controller and a 80x24 video section, all on the board, this unit makes an ideal low-cost system for the CP/M operating system.

The memory section has a number of unique features rarely to be found on any other machine. The circuitry is provided on-board for up to 256K of dynamic RAM (using 4164 64K x 1 chips). Jumper options allow the user to select one of three options with regard to wait states (no wait states, wait states on operation code fetches, or wait states on all memory accesses) so that the user can configure his system to his requirements. Four jumper-configurable sockets are furnished as well. Any mix of 6116/2016 (2K x 8 RAM); 2716 (2K x 8 EPROM); 2732 (4K x 8 EPROM) or 2764 (8K x 8 EPROM) can be placed in this socket, which can be enabled to shadow any other memory which would be addressed in these locations. It is also possible to disable these sockets in software, if the user wishes to do so. Full memory management is available on the board which can turn the Z80's standard 64K address space into the full 16 Mbyte 24-bit address space allowed by the S-100 bus standard. This memory management applies to the 256K RAM on-board, all other onboard memory, and all memory on the S-100 bus.

The board also contains a full-featured floppy disk controller. Based on the WD1793 IC, this section will handle any combination of 8" or 5¼" drives, whether they be single or double density or single or double sided. The newest technology was also used in designing the data separator circuit. This circuit is all-digital, allowing extremely reliable use in the double density mode. The floppy controller is fully compatible with both CP/M, giving the user full flexibility as to what operating system he wants to run.

For interfacing to the real world, the user is again given the flexibility to configure the system to his own needs. Supplied are 3 independant software and/or hardware controlled 16-bit timer counters, 2 of which are used to generate the baud rates for the 2 on-board RS232C serial ports. Both of these ports are programmable for either syncronous or asyncronous operation. A full 24-line software controlled parallel port and a real time (time-of-day) clock, which can be backed up with batteries if the user so wishes.

The real-time clock, the floppy controller, the timers, and any other

Multiflex Single Board

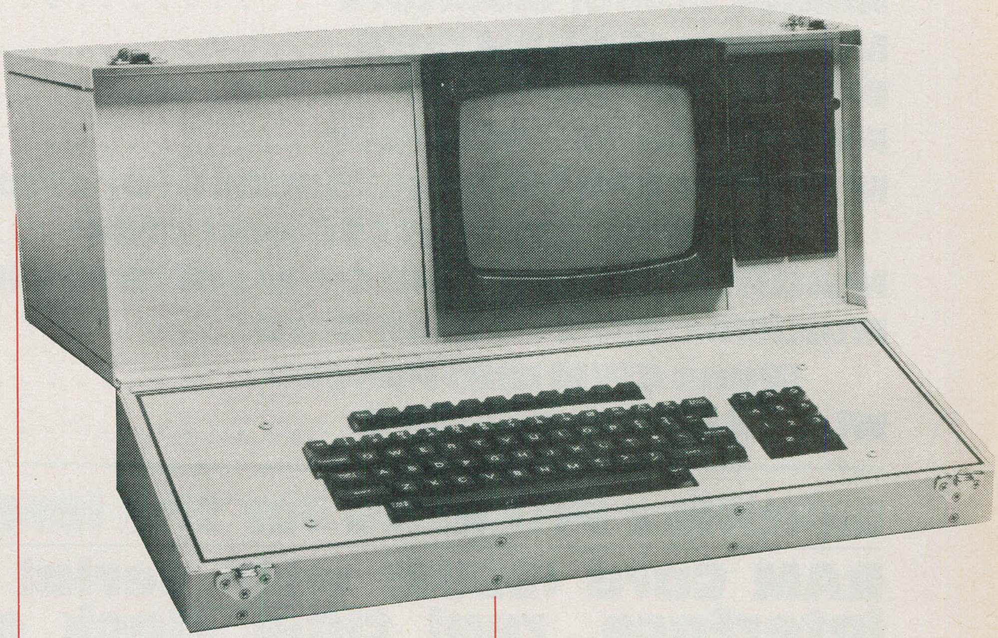
I/O port can be chosen to operate in a software selectable priority interrupt scheme. A second interrupt controller allows the on-board interrupts to be vectored with and other interrupts from external S-100 bus boards in a jumper selectable priority.

There is a full video section on the MULTIFLEX Single Board Computer as well. A second Z80 processor is used along with a 6845 CRT controller, giving the user a variety of features. Up to 8K of EPROM can be used to control the section, allowing emulation of a variety of terminals or room for custom display routines. 8K of static RAM is also provided for, this being used for the display buffer, the Z80's work area, and a print buffer. The print buffer can be used for the built-in Centronics-type printer port in the section. An ASCII keyboard port is also provided. The character generator on the board provides up to 256 characters and symbols, which are user-programmable since they are in a 2732 EPROM. The video output is available in two forms: a composite video signal, and the separate sync and video signals, allowing the board to be used with a variety of monitors. As well, circuitry for an optional RF modulator is provided on-board, for easy connection to a TV set. The actual display format in text is 80 characters by 24 lines. But, a 192 by 256 pixel graphics mode is also made available to the user. The resolution of this graphics mode can be changed by the user by providing additional software. A full, general, graphics interface (for joysticks, digitizing tablets, touch panels, etc) and a light pen input are provided so that user—friendly software is easy to implement on the system.

Overall, the MULTIFLEX Single Board Computer, with its numerous features can be many things to many users, from a full-featured Z80 development system to a very powerful CP/M based computer.

Multiflex 5¼'' & 8'' Systems.

We, at MULTIFLEX, are pleased to announce two new assembled and tested configurations of our new Single Board Computer systems. These systems are based on the MULTIFLEX Single Board Computer, a description of which is given on page 11.



THE TRAVELLING SYSTEM:
The first configuration is a portable, unit. It will provide for two slim-line 5¼ inch double-sided, double-density disk drives, mounted side-by-side vertically, a nine inch video monitor in the middle, and internally at the other end, room for an optional S-100 backplane which can plug into the Single Board Computer (it is terminated in a S-100 female card-edge connector). The backplane can hold up to 4 additional S-100 boards (extra memory, A/D + D/A, colour video, etc.). A switching power supply can be mounted internally and a hinged external keyboard along the front is part of the package. All this will result in a portable system which runs CP/M and all its compatible software.

$1850

THE BUSINESSMAN'S SYSTEM:
The second system is a full configuration business system. Included is a fully configured **Single Board Computer** complete with 256K bytes of RAM, a 4MHz Z80A processor, and all of the other exciting features of this remarkable system, including the CP/M operating system. Also included are two 8'' slim-line double sided, double density disk drives (SA860) and a powerful switching power supply. External connectors are provided for an ASCII keyboard, an external video monitor, extra external disk drives, two RS232C ports, and a Centronics-style printer connector. All of this gives the serious system user all the advantages of a fully loaded CP/M system in one small package.

$2895

THE SYSTEMS INTEGRATOR PACKAGE:
This configuration is suitable for systems developers or hobbyists wanting a powerful packaged system. It consists of three of our S100 cards: CPU Board with 64K of RAM on board, economy video board, floppy controller board and our six slot backplane. It also includes a keyboard and CP/M and a portable 12'' Zenith green screen monitor. It comes complete with two 8'' double sided, double density disk drives, and a very powerful switching power supply.This system allows the user to develop and test easily what ever circuitry he wants within his system. All the standard external connectors are provided, so that expansion and connection of external devices is simple.

$2950

Check out these Super Bargains

Fuller details elsewhere in this catalogue

Gemini 10X Printer	$369
Wizard Intelligent Printer Interface	$89
Wizard Buffered Parallel Output	$179
Multiflex Apple Compatible Disk Drive	$259*
Multiflex Apple Compatible Slimline Disk Drive, DS DD	$345**
Quentin Disk Drive	$299**
Micro Sci Disk Drive	$299**

*One year warranty **90 day warranty

Zenith ZVM-123 Monitors	$139
Amdek Colour Monitors	$395
Multiflex 16K RAM Card	$55
Wizard 16K RAM Card	$79
PDA 232 Serial Interface	$109
Multiflex EPROM Programmer for Apple (for 2716, 2732, 2732A and 2764)	$69
Multiflex Z80 Card (No CP/M software inc)	$55
Multiflex 80x24 Video Card (Runs CP/M and Pascal)	$79
Wizard 80 Column Card	$199

Multiflex Products for the IBM PC

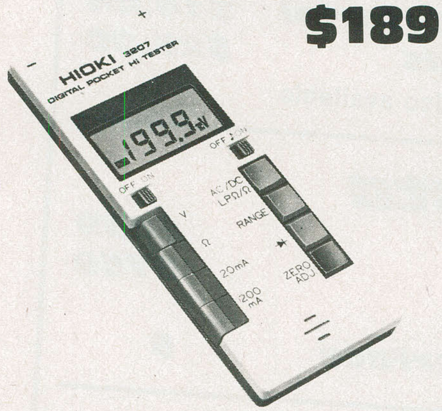
RAM Card (256K) with serial and parallel interface, real time clock and optional modem interface. Incredible bargain . . . Call for Prices

SA455 Slimline Disk Drive DS, DD	$299
Multiflex Disk Drive for the VIC-20 or Commodore 64, with power supply and intelligent interface	$389
Multiflex 300 and 1200 Baud Modem	$299
XR Modem Kit (as advertised in Byte)	$225
VIC-20	$169
Commodore 64	$359

Hioki Test Gear

3207 Digital Pocket Hi Tester

$189



Full Autoranging DMM

- Full autoranging
- Lo power ohms for in-circuit resistance
- AC/DC 10MΩ Input Impedance
- High sensitivity with 200mV range
- Alarm provided for continuity test work
- Diode check range
- Zero adjust function

3208 Calcu Hi Tester

$350

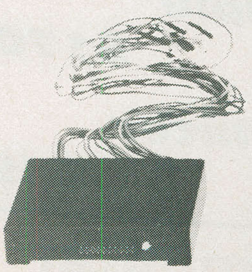
Calculator and DMM Capability

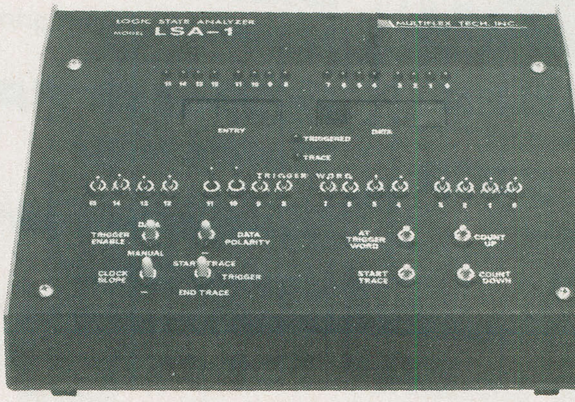
- A multimeter with a function calculator
- DMM display with one-touch keying-in of the calculator
- Lo power ohms for in-circuit resistance
- AC/DC 10MΩ Input Impedance
- Alarm provided for continuity test work
- Alarm indicates range selection and function selection
- Diode check range

Specifications 3207/3208

DC Voltage:	Range: 200m · 2 · 20 · 200 · 1000V	Ranging:	Automatic & Manual
Input Impedance:	10MΩ	Sample Rate:	2 samples per second
AC Voltage:	Range: 2 · 20 · 200 · 600V	Dimensions, Weight:	3207: 150H×60W×12D mm, Approx. 120g 3208: 170H×76W×20D mm, Approx. 250g
Input Impedance:	10MΩ Freq.: 40 ~ 500 Hz	Calculator:	Separate Entry/Function keys
		Display:	8 digits sign or 5 mantissa and 2 exponent with sign
AC · DC Current:	Range: 20m · 200mA	Accessories:	Test Leads, 3207: Soft Case 3208: Carrying Case Fuse (0.3A)
Resistance:	Range: 0.2 · 2k · 20k · 200k · 2000kΩ		

The Multiflex LSA





Multiflex Low-Cost Logic State Analyzer

You've just completed a microprocessor system, and it doesn't work. What next? You can use an oscilloscope to check for clock signals and the like, but if everything appears to be in order you can't go much further without sophisticated equipment. In these situations, professionals turn to their logic state analyzers, each of which cost thousands of dollars. MULTIFLEX has the answer for all those people who don't want to take a mortgage on their house just to get a computer working. The MULTIFLEX Logic State Analyzer has all the essential features of those more expensive units at a fraction of the cost. This is a high-quality piece of test equpment, suitable for industrial or scientific use, but its price is well within the price range of a hobbyist.

Easy to understand and operate, the Logic State Analyzer allows you to monitor 16 points in a digital system (ie. data and/or address bus, or control lines) which carry continually changing signals. You can select a bit pattern you expect will appear at these points. Once the pattern appears the Analyzer will trigger and record ("freeze") the next 1023 bit patterns so that they can be examined step by step even though data is no longer available in the unit being examined. For software development the Analyzer is invaluable, especially in dedicated systems. If you design a microprocessor system for a specific function, and you have no monitor, assembler or other such software, the best and often only way to debug the system is to use a logic analyzer. It will let you look closely at the data flow as a program is executing, or monitor the address lines to make sure that the instructions are being executed in the proper sequence. The various control lines such as memory read and write, DMA, interrupts, or enable and disable signals can also be examined. You can, of course, monitor any combination of these signals, such as the data bus and half of the address bus, or half of each plus 4 control lines. The combinations are endless.

A special feature of the MULTIFLEX Logic State Analyzer is that any number of units can be interconnected for dealing with larger input words. With two Analyzers, you can monitor the address and data bus of an 8-bit processor at the same time and have 8 spare signals to monitor the control lines, I/O signals or signals from external devices. Anyone who will be doing any systems debugging should take a close look at this unit, since its features and low price tag make it an asset.

Kit with case $295
A&T $395

PRINTER SPECIALS

Epson

FX80 **$845**
8½" Dot Matrix with enhanced Graftrax 160 CPS.

MX100 **$1095**
15" Dot Matrix with Graftrax - 100 CPS

FX100 **$995**
15" Dot Matrix with enhanced Graftrax 160 CPS.

8155 Serial Interface $190
with 4K Buffer

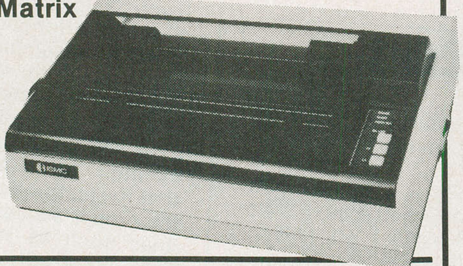
Letter Quality

TTX 15" DAISY WHEEL PRINTER 16 CPS bidirectional and logic seeking. Many software features - reverse line feed; standard feature parallel and serial inputs. One of the best printers on the market at an affordable price of

BMC Printer

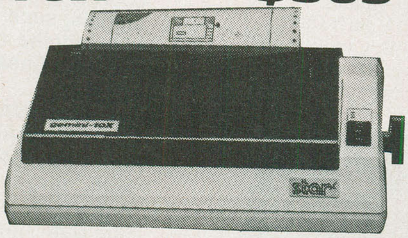
80 CPS Dot Matrix

$349



Gemini 10X $369

- 9x9 Dot Matrix
- 120 CPS
- 4 Print sizes
- max. paper width: 10"
- dot addressable graphics
- user definable character set



Gemini 15 $599

- 9x9 Dot Matrix
- 100 CPS
- 4 Print Sizes
- max. paper width: 15"
- dot addressable graphics
- proportional spacing

RF Mods $14.00

Applesoft Tutorial **$14.44**
DOS Manuals **$25.00**
Printer Manuals also available

Oki Data

mL 82A **$639**
mL 92 **$759**
70001301
Serial Interface **$**

Paper

Control Data 9½" x 11" plain - 500 sheets	$10.44
Box 2400 sheets long 15½" x 11"	$45
short 8½" x 11"	$55
Mailing labels - Multicopy forms available	$14

Interfaces

Wizard **$184**
Apple™ compatible Wizard BPO-16 16K Parallel Buffer Printer Card

Wizard BPO-32 $224
32K parallel buffer printer card

Wizard **$84**
IPI parallel intelligent printer interface

Microtek Apple Dumpling **$170**

Multiflex printer interface **$69**

We will make cables for any computer on the market min. $35

New Exceltronix Products

MULTIFLEX QUAD

The MULTIFLEX QUAD is the least expensive way to add a full featured multifunction board to your IBM-PC. This board contains 256K of parity-checked RAM, a real-time clock/calendar, a RS232 serial port and a parallel printer port. all of this allows you to expand your PC to new heights of usefulness and functionality in one great leap, for once you have the QUAD you can ask the computer the time (and have it reply), or talk to other machines, and never run out of room while using that important program. All of this is available to you for an unbelievably low price.

MULTIFLEX HARD DISK STORAGE SYSTEM:

Are you constantly running out of disk space on your APPLE, IBM or S-100 computer? Are you tired of waiting while your DOS tries to find that important file on the disks? Then you should get the MULTIFLEX Hard Disk Storage System. The system consists of a 10M byte 5¼" hard disk drive, a full featured hard disk controller (that will handle up to 4 hard disk drives), a host adapter board which fits the particular computer you are using, and a new disk operating system for the computer which allows you to use the hard disk system in your system. The system will be available in 3 versions: one for the APPLE II, one for the IBM-PC, and one for an S-100 based system such as the MULTIFLEX super system.

MULTIFLEX DRIVE FOR VIC-20/C-64:

The MULTIFLEX drive for the VIC-20/C-64 is a low cost alternative to the COMMODORE 64 computers. It is completely compatible with all programs and data now prepared on COMMODORE equipment and uses the same commands for accessing the data on the diskette. All of these features and many more are available at a substantial savings from the original equipment.

MULTIFLEX INTELL-MODEM:

The MULTIFLEX Intell-Modem is a 300 or 1200 baud direct connect modem with intelligence. This intelligence allows interactive control of the modem from your computer or terminal. It allows you to auto-dial phone numbers (and redial if the number is busy), automatically answer the phone, and automatically select the correct baud rate to communicate at. It also has a front panel bank of LEDs to give the status of the modem and communications line at a glance. And you get all of this and more for an incredibly low price.

Multiflex 256K - Byte RAM Card Kit

This is a brand new product from the MULTIFLEX line of state-of-the-art IEEE 696/S-100 compatible boards. This board gives the user up to 256K of dynamic RAM with full 24 bit addressing which can transfer data on an 8 bit wide path and in the new IEEE 16 bit method for 16 bit processors. The standard board includes 8 150 or 200ns 4164 64K x 1 dynamic RAM chips (ie. 64K of memory) which will run comfortably at 4 MHz and in some cases may be good up to 6 MHz. However, if it is intended to use this RAM Card solely at 6 MHz, we strongly recommend that you, when you order, specify 120ns 4164's, which can be supplied at a slight additional charge. The refreshing of the RAM can either be handled externally (if you use a Z80 processor) or internally. If no refresh signal is available on the bus (due to wait states or use of a processor that does not supply a refresh signal) the internal refresh acts as a fail-safe, by supplying the refresh signal to protect the contents of your memory. Wait states can be jumper selected in, so that memory not capable of running at the speed of the processor can be used if desired. Another important feature of this board is its compatibility with both the CP/M and MP/M operating systems and a bank-select feature for use of more than one of these boards in the system. There is also a write protect option which allows the user to load something (eg. an operating system kernal) into memory and then protect it against accidental erasure.

Kit with 64K $295
A&T with 64K $395

MULTIFLEX EPROM PROGRAMMING SYSTEM:

This new product from MULTIFLEX is a superb EPROM programming system. It programs up to 8 EPROMS at a time and can handle 2716, 2732, 2732A, 2764, 27128, 27256, 2532, and 2564 chips. Based on an Z8 processor, this system can be used to locally enter and edit data, as well as download from a RS232 serial port. A socket for master EPROMs makes copying a breeze, and that master need not be of the same type as the copys (ie. you can copy from a 2732 to a 2532, etc.). All of these features and the many more make this EPROM programmer the one to have.

MULTIFLEX 212A MODEM DESIGNERS SYSTEM

This 212A compatible modem is based on the EXAR series of modem chips. The XR2123 CMOS modulator/demodulator required for 212A compatibility and the XR2120 provides the 1200 and 300 baud filtering. Based on these CMOS/LSI components we can offer a modem completely compatible with the BELL 212A standards at an extremely low cost with enhanced reliability since the LSI circuits reduce the number of active components and the space to house them.

With the addition of the MULTIFLEX Intelligent Modem Controller you receive a smart modem, which is software compatible with other popular modems on the market today.

MULTIFLEX MODEM DESIGNERS KIT (A&T) $349.95
MULTIFLEX INTELLIGENT MODEM CONTROLLER $149.95
BOTH TOGETHER $449.95

Contact us for package deals

As these are new products, call us for prices or follow release dates and pricing in our ads in ETI magazine.

Slimline Disk Drives

The **MULTIFLEX** Slim-line Disk Drive for the APPLE II series of computers is a double-sided drive which gives the user double the storage space of a regular APPLE-compatible disk drive. It is still, however, APPLE compatible with all the various APPLE software, so that programs that have already been developed for the computer can be run under their own DOS.

$359

80-Column Card

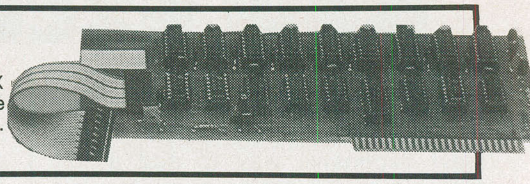
FEATURES:
*Gives 80 columns and upper/lower case on your APPLE II/II+/IIe computer.
*Works with PASCAL and CP/M.
*Auto-switch between 40 columns and 80 columns.
*Full inverse video.

The **MULTIFLEX** Video-80 card allows the user of an APPLE II computer to have an 80x24 text display with upper and lower case characters. This board allows the user to switch from a 40 column display to a 80 column display, and run PASCAL, CP/M and show APPLESOFT programs in 80 columns.

$79

16K RAM Card $55

Expand your 48K APPLE to 64K. The MULTIFLEX 16K RAM Card allows other languages to be loaded into your APPLE from disk or tape. Allows APPLE CP/M users to run CP/M 56.



Multiflex Z-80 Card

This card allows the user to run Z80/8080 programs on his APPLE II/II+/IIe computer. Specifically, it allows him to run the CP/M operating system, with all its attendant software, such as word processors, accounting packages etc.

$55

(CP/M not included)

Multiflex Semi Disk

FEATURES:
*Fully compatible with APPLE computers
*256K of fast dynamic RAM.
*Works like 2 disk drives.

The **MULTIFLEX SEMI DISK** is a disk emulator board for the APPLE II range of computers. With its 256K bytes of RAM, it looks to the computer like two very fast disk drives. This makes the use of various data base programs, and other software that use more than one drive extremely easy because the wait time until the next module is loaded is minimal, thus increasing the productivity of the user immensely.

$379

No software included

Multiflex EPROM Programmer

FEATURES:
*EPROM programmer for APPLE computers.
*Programmes 2716, 2732, 2732A, 2764.
*ZIF socket for the EPROM.
*Complete with software.
*Built-in programming supply.

The **MULTIFLEX** EPROM Programmer Card for the APPLE II/II+/IIe computers allows the user to create his own software and then store it on an EPROM for use in another system. This card, with its on-board programming supply, can program 2716 (2K x 8), 2732 or 2732A (4K x 8), and 2764 (8K x 8). Included with the card is a disk full of software, which using menus allows the user to program or verify EPROMs, check if they are blank, set pointers anywhere in memory, and save or load memory ranges to/from the disk drive, making this unit a very versatile piece of hardware for the hardware developer or the hobbiest.

$99

Multiflex Drive for Apple

FEATURES:
*SA390L base drive.
*APPLE compatible.
*Complete with case.
*One year warranty.

The MULTIFLEX APPLE-compatible disk drive is a standard Shugart SA390L which has been modified to work with the APPLE II/II+IIe computers. It is compatible and handles all the special protection disk operating systems that are in use (including those that use "half-tracking"). This drive, in a case, complete with a year's warranty is available with or without a controller card

Drive with controller $349
Drive only $269

Apple II Printer Cards

MICROTEK APPLE DUMPLING CARD: $170
This card gives the user full control of his printer directly from his APPLE II/II+/IIe keyboard, including graphics and text screen dumps. It comes complete with a cable for a printer with a standard Centronics-style interface.

ORANGE MICRO GRAPPLER+: $235
The Grappler+ interface is uniquely capable of performing a wide range of both text and graphic commands, such as: Dual Hi-Res graphics; keyboard programming; DIP switch printer selection; Inverse, Rotated, or double sized graphics; skipover-perf; Left and right margin variation; and Variable line length.

PURE DATA PDA-232 SERIAL CARD: $95
The PURE DATA PDA-232 is a complete serial card for the APPLE II/II+/IIe computers. Its on-board software allows to make the APPLE into a dumb terminal, allows the APPLE to be accessed remotely or as a simple I/O device to allow connection to a printer, modem etc. It also allows for software and/or hardware baud rates and character types.

Check with our ads in Electronics Today and Computing Now! or call us for information on availability.

Apple® IIe

$1795

FEATURES:
*Upgraded version of the APPLE II+.
*64K of RAM now standard.
*Full upper and lower case keyboard.
*High-resolution graphics.
*Wide software and hardware support.
*All standard APPLE features.
*Built-in self-tests.

The APPLE II+ was one of the world's most popular home microcomputers. The brand new APPLE IIe is a redesigned and upgraded version of this computer. Some of the features common to both computers are: a 40x24 text display, 290x192 high resolution graphics in 6 colours, 40x48 low resolution graphics in 16 colours, a 6502 microprocessor, built-in keyboard, composite video output, built-in cassette interface, a joystick/paddle interface, and a full set of I/O bus connectors. It is all of these features that made the APPLE II+ so popular, and it is this that make the APPLE IIe compatible in all ways to the old machine.

The new features of the APPLE IIe are 64K of RAM on-board (instead of 48K), a full 64-key upper/lower case ASCII keyboard with auto-repeat that puts out all 128 ASCII codes and has 6 new keys (DELETE, "open-apple", "closed-apple", TAB, "up-arrow", and "down-arrow"), all logic circuitry built into 3 custom IC's allowing for easier service and lower power consumption, 16K of firmware including a set of self-test routines and new video handling routines, an AUX connector with virtually every useful computer signal available for use by peripheral devices, an internal "power-on" light to remind you not to connect or disconnect anything inside the computer while the power switch is on, and a redesigned back panel that gives the user better control of the cables coming out of his computer.

Even with all of these remarkable features, the APPLE IIe still remains fully compatible with the old APPLE II+, and any software that was written for the APPLE II+ will run on the new machine.

Apple Disk II

The APPLE DISK II is a mass-storage floppy disk drive for any of the APPLE II series of computers. Each unit stores up to 124K bytes of user information per diskette (under DOS 3.3) using a single sided, single density diskette. It will run any program written for the APPLE II/II+/IIe computers. The DISK II can be supplied in one of two forms: as a first drive (c/w DOS 3.3 controller card, DOS 3.3 diskettes, and DOS 3.3 manual), or as a second drive (just the drive itself). Each APPLE Disk Interface Card can control two of these DISK II (or equivalent units).

Drive with controller $795
Drive only $750

Hardware for Apple®

APPLE][+ c/w 48K $1195.00
APPLE][e $1795.00
MULTIFLEX Disk Drive c/w controller **$349.00**
MULTIFLEX Disk Drive **$269.00**
MULTIFLEX 16K RAM Card ... **$55.00**
MULTIFLEX Z80 Card **$55.00**
(No software included)
MULTIFLEX EPROM Programmer Card **$69.00**
Pure Data PDA-232 Serial Card **$109.00**
Microtek Apple Dumpling Printer Card **170.00**
Videx videoterm 80-column Card **495.00**
Videx Enhancer II **199.95**
Videx Function Strip **109.95**
Hayes Micromodem II **495.00**
Novation Apple-Cat II **539.00**
T.G. Joystick **65.00**
T.G. Paddles **60.00**
Mountain Computer CPS Multifunction Card **330.00**
Orange Micro Grappler+ Card **220.00**

Apple is a trade mark of Apple Computer Inc.

Exceltronix

Apple Software

GAMES

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Empire of the Overmind	44.95
The Sorceress	28.95

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Raster Blaster	39.95

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DATASOFT

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Jumpman	52.50
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Phasar Fire	34.95
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SIERRA ON-LINE

Cannonball Blitz	47.95
Crossfire	39.95
Frogger	39.95
Hi-res Cribbage	34.95
Hi-res Football	46.95
Hi-res Soccer	38.95
Jawbreaker	37.95
Laffpack	44.95
Lunar Leeper	37.95
Maurader	44.95
Mouskattack	44.95
Mystery House	32.95
Pest Patrol	28.95
Sabotage	31.95
Soft-porn Adventure	39.95
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Hadron	42.95
Kabul Spy	39.00
Minotaur	43.95
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Magic Words	

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D-Base II	810.00

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Applewriter II +	119.95
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Accounting Package: General Ledger, A/R, A/P, Inventory	1365.00

BPI

General Ledger	499.95
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Accounts Payable	499.95
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Canadian Payroll	479.95

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Supersort	310.00
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Multi-tool Expert Systems	
Multi-tool Financial Statement	
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MUSE

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Lisa Educational Pak	157.00
Screenwriter II	170.00

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Peach Text	350.00

Apple Software

List Manager	350.00
Spelling Proof Reader	220.00
Peachcalc	220.00
Series 40 Sale Pak:	
G/L, A/R, A/P	575.00

SILICON VALLEY

Wordhandler	259.95
List Handler	116.95

SOUTHWESTERN DATA SYSTEMS

ASCII Express II	78.50
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The Correspondent	78.50
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D.B. Master	289.00
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Tic Tac Show:	
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Gulp/Arrow Graphics	45.95
Jar Games/Chaos	45.95

MUSE

The Voice	49.95

HAYDEN

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Zoom Graphix	56.95

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Bag of Tricks	46.00
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Super Disk Copy III	38.95
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Story Machine	42.95

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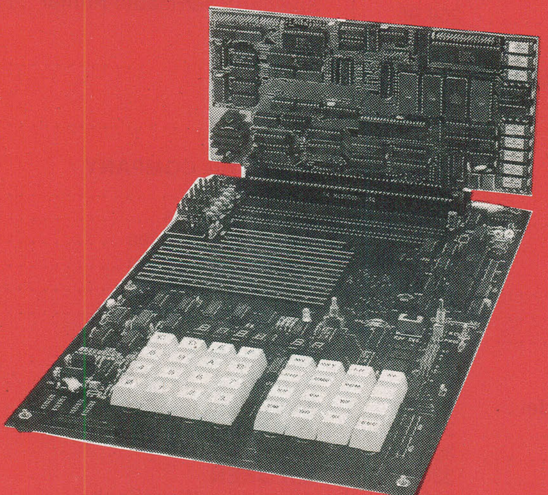
Applewriter/Videoterm Pre-boot	27.95
Visicalc/Videoterm Pre-boot	64.95

MULTIFLEX Z80 EDUCATIONAL SYSTEM

The Multiflex Z80 Educational computer is an ideal trainer system for the teaching of microcomputer techniques to students. When this system is expanded using the optional peripheral components it can also be turned into a full-fledged, extremely powerful CP/M based computer system, making it flexable enough to allow the teaching of computer concepts from basic digital electronics to microcomputer software on the operating systems level.

The basic unit (which is described on p. 20 of this catalogue) is ideal for a course in digital electronics or in elementary computer hardware. The monitor software that is included in the basic unit allows the input of simple machine language programs to control the hardware, or direct control of the I/O ports so that interfacing techniques can be learned quite simply. There is a 40-chip wire wrap/prototyping area on the mother board with easy access to all the bus signals so that custom interfacing can be learned. The cassette interface allows programs, once properly working to be saved for future use or modifications. An EPROM programmer is also built into the system so that the most commonly used subroutines can be built into permanent memory and used over and over again. Also available are 2 24-bit parallel ports, 3 16-bit counters and an optional RS232 serial port for interfacing external peripherals to the computer.

With the addition of the floppy disk interface and the video monitor interface and a floppy disk drive, the MULTIFLEX Z80 Educational System turns into a full blown CP/M-based operating system. This gives you all the advantages of the basic unit plus additional software capabilities for exposing the student to the industry standard operating system. With this system the student can learn about assembly language programming, and other aspects of the software ends of computer such as word processing and higher level languages like BASIC, Pascal and "C". It also gives flexability for the teaching staff to set up demonstrations and experiments on disk prior to the lab



period so that less time is wasted on setting up the equipment and more practical time is gained. A full interactive monitor can also be obtained so that all functions of the basic monitor are handled through the keyboard and video interface. With this monitor and CP/M, both the software and hardware aspects of interfacing equipment to a microcomputer can be demonstrated effectively and efficiently.

A sample course based on this unit might include the following topics:

* Introduction to Z80 machine language programming
* Introduction to Z80 assembly language programming (if using the enhanced system)
* Serial I/O communication
* Parallel I/O communication
* Hardware interfacing (eg. a hex keypad)
* Interrupts
* Subroutines
* Tables and Lists
* Operating systems programming (with the enhanced system)
* Human Interface programming (with the enhanced system)
* Custom circuit design and interfacing

MULTIFLEX 6809 EDUCATIONAL SYSTEM

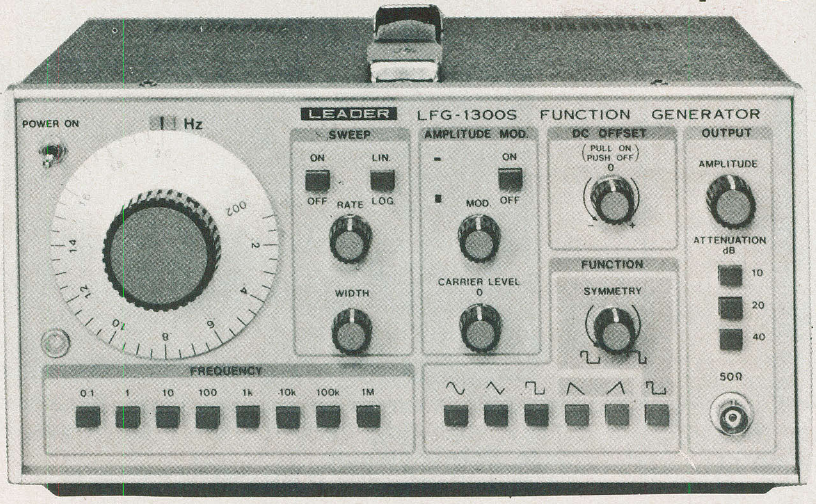
The MULTIFLEX/U of T 6809 Educational system is the ideal system for the teaching of microcomputer interfacing and software. The package consists of the University of Toronto 6809 computer, the MULTIFLEX Intelligent Terminal, and a 12" monitor. Included with the 6809 board is a full-screen/editor assembler package that was especially designed by the University of Toronto for use by students in learning the basics of microcomputer hardware and software. Some of the features of this software (which is contained in 12K ROM on-board) are full breakpoint/single-step capability for program debugging, a telecommunications mode which allows communications and information transfer between computer systems, register examine and set, and many more. The software also handles file transfer to and from the built-in cassette interface.

Educational Institutions Accounts Welcome

Leader Test Gear

2MHz Sweep Function Generator

$949



The LFG/1300S is a general-purpose signal source with a broad range of research, design and service applications. Outputs include sine, square, triangle, ramp and pulse signals. Pulse symmetry is variable over a 9:1 range and, unlike many other instruments, changing the symmetry does not appreciably affect the output frequency. Linear and logarithmic sweep frequency outputs are available with sweep widths up to 1,000:1. Output level is controlled by a calibrated 70-dB attenuator (10-dB/step) with continuous adjustment between steps. The output may be frequency or amplitude modulated by an external signal. A level control also provides suppressed carrier outputs. The LFG-1300S is housed in a sturdy metal housing with a "human-engineered" front panel for convenient, simple operation.

General Purpose 'Scopes

The LBO-310A is a compact, general purpose instrument designed to provide long, reliable service in production test, repair, and educational applications. Its simple front panel with a minimum of controls makes it ideal for use by production personnel, students, and non-technical operators. Its low cost opens up many applications where waveform monitoring might otherwise be economically prohibitive. Sensitivity is 20 mV/division. Sweep frequencies range from 10 Hz to 100 kHz.

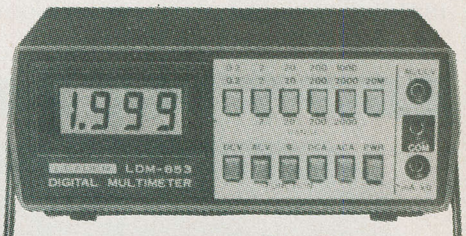
$349

LBO-310A

LBO-510A

The LBO-510A is a best buy general purpose oscilloscope. Ideal for service, education and communications. Solid State design delivers H MHz vertical bandwidth plus 20 mVp-p/Div vertical sensitivity. Bright, easy to read display — use multiple units for monitoring several phenomena simultaneously.

$529



3½ Digit LCD Multimeter

SPECIFICATIONS

DC Voltage
100 μV — 1000 V 5 ranges
Accuracy:
± .3% rdg + 1 dgt
(100 μV — 200 V)
± .6% rdg + 1 dgt (200 V — 1000 V)

AC Voltage
100μ V — 1000 V 5 ranges
± 0.5% rdg ± 2 dgt
(100μ V — 200 V)
+ 0.8% rdg + 4dgt. (200 V — 1000 V)

in)

DC Current
1μ A — 2A 4 ranges
Accuracy
± 0.4% rdg + 2 dgt.
+ 1.5% rdg + 2 dgt.

AC Current
1μ A — 2A 4 ranges.
accuracy
1.8% rdg + 3 dgt.

Resistance
0.1 ohm — 20 M ohm 5 ranges
accuracy
± 0.3% rdg + 2 dgt.
(0.1 — 2 M ohm)
± 0.6% rdg ± 2 dgt.
(2 M ohm — 20 M ohm)

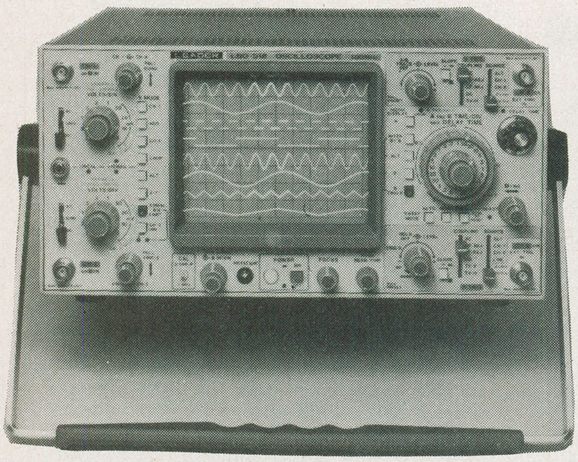
Compact, rugged and accurate; the LDM-853 is uniquely suited for both laboratory and field work with either AC or battery power. Operation is easy and straightforward. The LDM-853 features high accuracy of 0.3% (D.C.V.) and employs 0.2V ranges which are capable of 100 μV resolution. Current measurement to 2 amp on both AC and DC ranges. Automatic polarity and automatic zero are also provided for your convenience.

$359

Exceltronix

Leader Oscilloscopes

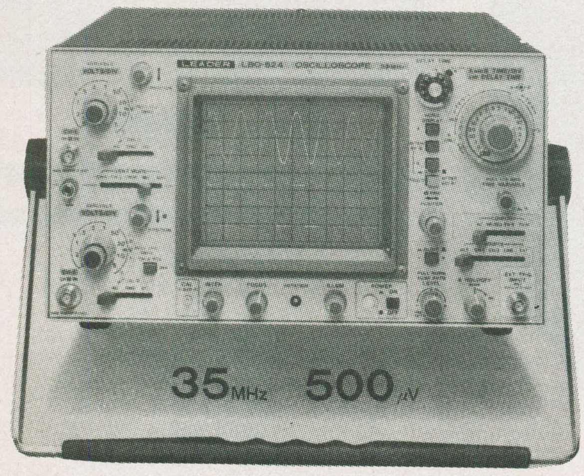
LBO-518



This is a 100MHz, 5mV/div oscilloscope (500 uV/div at x10 MAG) and maximum horizontal sweep speed is 2 n-sec at x10 MAG. Its applications cover not only production and service maintenance but also research/development.

$3589

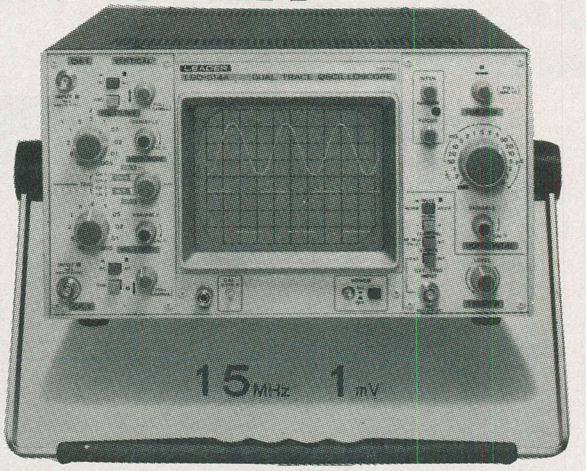
LBO-524/524L



- CRT: 150mm, Rectangular, Internal-graticule (8 x 10div: 1div = 1cm), Post-acceleration (7kV), Flat-face, Metal-back, Dome-mesh, % Scale, Scale Illumination, Beam Rotation.
- Delayed Sweep (Continuous/Triggered) • Wide Bandwidth: 35MHz (5mV, 8div Ref.) • Max. Sensitivity: 500uV (MAG x 10, 5MHz) • Max, Sweep Speed: 20ns/div (MAG x 10) • TV-V, TV-H Sync. Separation
- ALT Trigger • Hold-off Variable • X-Y Operation
- PRESET Synchronization • Linkage of Frequency Counter Using CH-1 OUT, • TTL Level Z MOD. • The model LBO-524L offers a signal delay line which permits viewing the leading edges of pulses.

LBO-524 $1695
LBO-524L $1939

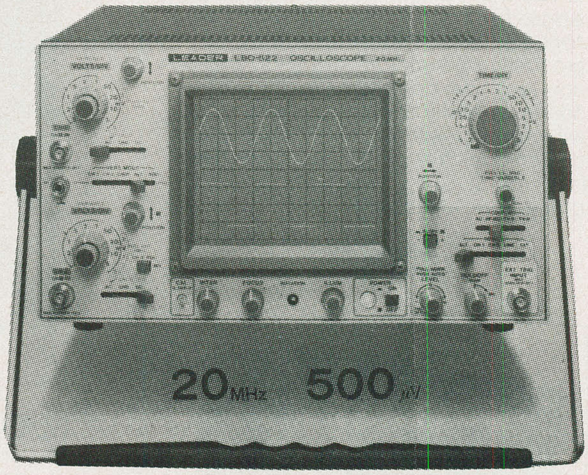
LBO-514A



- CRT: 130mm Round, Stabilized Acceleration 1.8kV, High Brightness & Clear Sharp Trace, Flat-face, Beam-Rotation
- Wide Bandwidth: 15MHz (5mV, 6div Ref.)
- Max. Sensitivity: 1mV (MAG x 5, 6MHz)
- Max. Sweep Speed: 100ns/div (MAG x 5)
- HF-REJ trigger for stable display which includes HF-noise & TV-Vert.
- X-Y Operation • TTL Level Z MOD.

$919

LBO-522



- CRT: 150mm, Rectangular, Internal-graticule (8 x 10div: 1div = 1cm), Post-acceleration (7kV), Flat-face, metal-back, Dome-mesh, % Scale, Scale Illumination, Beam Rotation
- Wide Bandwidth: 35 MHz (5mV, 8div Ref.) • Max. Sensitivity: 500uV (MAG x 10, 5MHz) • Max. Sweep Speed: 20ns/div (MAG x 10)
- TV-V, TV-H Sync. Separation • ALT Trigger • Hold-off Variable
- X-Y Operation can be controlled Manually & by REMOTE
- PRESET Synchronization • Linkage of Frequency Counter Using CH-1 OUT.
- TTL Level Z MOD.

$1049

Hameg Oscilloscopes

Specification

Vertical Deflection (Y)

Bandwidth: DC to 10MHz (−3dB),
DC to 15MHz (−6dB).
Risetime: approx. 35ns.
Overshoot: max. 1%.
Deflection coefficients: 12 calibr. steps, 5mV/cm to 20V/cm in 1-2-5 sequence, accuracy better than ±5%.
Input impedance: 1MΩ//25pF.
Input coupling: DC-AC-GD.
Input voltage: max. 500V (DC + peak AC).

Timebase

Time coefficients: 18 calibrated steps, 0.5μs/cm to 0.2s/cm in 1-2-5 sequence, with variable control uncalibr. to 0.2μs/cm, accuracy better than ±5% (in cal. position).
Normal length of baseline: approx. 6 cm.

Trigger System

Source: internal or external.
Slope: positive or negative.
Modes: Manual Trigger level control, Automatic Triggering (AT).
Sensitivity: 3mm (2Hz to 30MHz).
external: 0.5-5V, AC only.

Horizontal Deflection (X)

Bandwidth: 1 Hz to 1 MHz (−3dB).
Deflection coefficient: approx. 0.75V/cm.
Input impedance: approx. 1MΩ//25pF.

Component Tester

Test voltage: max. 8.6 V rms (open circuit).
Test current: max. 28 m A rms (shorted).
Test frequency: 50 resp. 60Hz.
Test circuit grounded to chassis.

General Information

Cathode-ray tube: 3RP1A, 7cm dia.
Accelerating potential: approx. 1kV.
Built-in square-wave generator 1kHz for probe alignment (0.2V±1%).
Electric regulation for all important supply voltages incl. high voltage.
A.C. Supply voltages: 110, 127, 220, 237V AC.
Maximum A.C. Supply: fluctuation: ± 10%
A.C. Supply frequency: 50 to 60 Hz.
Power consumption: approx. 24W.
Weight: approx 8¼ lbs.
Dimensions: 4.5″×8.3″×12″.
Finish: dark grey.
With handle and tilt stand.

Subject to change.

$489

Specification

Vertical Deflection (Y)

Bandwidth of both channels
DC-20 MHz (-3dB), DC 28 MHz (-6dB).
Rise time: 17.5 ns (approx.).
Overshoot: 1% (maximum).
Deflection coefficients: 12 calibr. steps, 5mV/cm - 20V/cm (1-2-5 sequence), accuracy better than ± 3%.
Input impedance: 1 Megohm II 25 pf.
Input coupling: DC-AC-GND.
Input voltage: max. 500V (DC + peak AC).
Operating modes
Channel I, Channel II, Channel I and II, alternate or chopped (approx. 120kHz).
X-Y operation: sensitivity ratio 1:1.

Timebase

Time coefficients: 18 calibrated steps, 0.5 us/cm-0.2 s/cm (1-2-5 sequence), with variable control uncalibr. to 200 ns/cm, with magnifier x5 uncalibr. to 40ns/cm, accuracy better than ± 3% (in cal. position)
Ramp putput: 5V (approx.).

Trigger System

Modes: automatic or variable trigger level.
Sources: Channel 1, Ch. II, line, external.
Slope: positive or negative.
Coupling: AC or TV-low-pas-filter.
Sensitivity: int. 3mm, ext. 0.7V (approx.).
Bandwidth: 30 Hz (auto), 5 Hz (level) up to at least 30 MHz.

Horizontal Deflection (X)

Bandwidth; DC-2 MHz (-3dB).
Input: via Channel I, for other data see Y deflection spec.
X-Y phase difference: <3° up to 100 kHz.

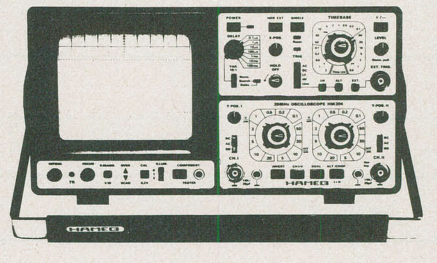
Miscellaneous

Cathode-ray tube: 130 BXB31, 13 cm Ø.
Accelerating potential: 2000V.
Calibrator: square-wave generator 1 kHz, 0.2V ± 1%, for probe compensation.
Trace rotation: adjustable at front panel.
Regulated DC power supplies: all operating voltages including the EHT.
Line voltages: 110, 125, 220, 240V AC.
Line fluctuation: ± 10% (maximum).
Line frequency range: 50-60 Hz.
Power consumption: 36 Watts (approx.).
Weight: 6 kg (approximately)
Dimensions (mm): **H** 145, **W** 285, **D** 380.
Finish: dark grey.
With handle and tilt stand

Subject to change.

$750

HM204



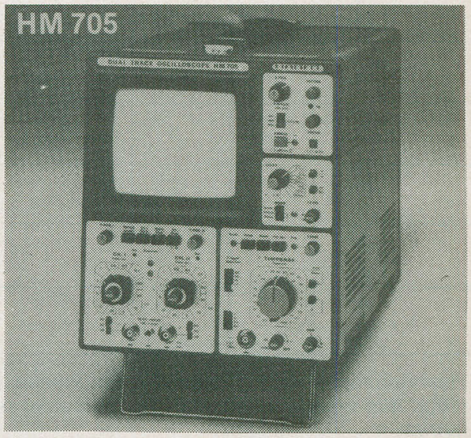
- **2x 20MHz, max. 2mV/cm** — max. 1% Overshoot
- **Component Tester** — One-Button Operation
- **8x10cm, Rectangular CRT** — Internal Graticule (illum.)
- **Timebase 20ns/cm - 2s/cm** — incl. Magnification x10
- **Trigger Bandwidth 50MHz** — internal at 5mm
- **Delayed Sweep 100ns – 1s**

The new HM204 demonstrates the exceptionally high quality and operating standards set by HAMEG, providing **a multitude of features** normally found only in more expensive scopes. The rectangular **8x10cm CRT** has a quick-heating cathode, burn-in resistant Phosphor, and an internal graticule, which can be illuminated. Each channel is electronically switched to the vertical final amplifier in either **alternate or chop mode**.
Although the bandwidth of the HM204 is rated at **20MHz** -3dB (70% of 80mm), the 50MHz bandwidth of the preamplifiers permits viewing of signals up to 40MHz at smaller display heights. HAMEG's **overscan indication** is superior to the common beam finder, as it will also show the presence of signal components or fast spikes outside the vertical limits of the CRT screen.
The HM204 may be operated as a **single or dual trace** oscilloscope. The **sum of two channels** is displayed in **Add Mode**, their difference by using the **Invert function** of Channel I. In **X-Y Mode**, both channels have equal input impedance and sensitivity ranges.
The wide timebase range from 20ns/cm (incl. **Magn. x10**) to 2s/cm provides excellent resolution of all signals. HAMEG's new LPS trigger technique ensures reliable triggering even on small signal heights (5mm) up to 50MHz. Normal and fast **Automatic Peak Value Triggering** and **Variable Hold-Off** time permit stable displays of very complex or aperiodic signals. The **Alternate Trigger Mode** ensures jitter-free display of two asynchronous signals, while the **Single Sweep** facility allows the investigation of single events and accurate photography. The **Sweep Delay** is particularly useful for the analysis and expansion of complex waveforms, offering almost all the advantages of a second timebase at much lower cost. **Component Tester, Z-modulation, raster illumination, ramp output, trace rotation** and **built-in calibrator** are standard with this most versatile and competitive scope.

Accessories included:
2 switchable Probes x1/Reference/x10; Operating Manual, Line Cord; Pair of Tester Leads

Accessories optional:
Probes x1; x10; x100; Demodulating Probe; various Test Cables; Viewing Hood; Carrying Case; etc.

$1145



Specification

Vertical Deflection (Y)

Bandwidth of both channels:
DC-70MHz (-3dB), DC-90MHz (-6dB).
Risetime: approx. 5ns.
Overshoot: maximum 1%.
Deflection Coefficients: 12 calibr. steps, 5mV/cm-20V/cm (1-2-5 sequence), with variable control (1:2.5) to **2mV/cm.**
Accuracy: within 3% in cal. position.
Input Impedance: 1 Megohm II 25 pF.
Input Coupling: DC-AC-GND.
Input Voltage: max. 500V (DC + peak AC).
Overscanning Indication: by 2 LED's.
Delay Line: to view leading trigger edge.

Operating Modes

Channel I, Ch. II, Ch. I and Ch. II, alternate or chopped (approx. 1 MHz).
Algebraic Addition: Ch. 1 + II, CH. —1 + II.
Difference: with Channel I inverted.
X-Y display: X via Ch. II, Y via Ch. I.

Timebase

Time Coefficients: 23 calibr. steps, 50 ns/cm - 1 s/cm (1-2-5 sequence), with variable control (2.5:1) to 2.5s/cm.
With expansion x10 to **5ns/cm.**
Accuracy: within 3% in cal. position.
Ramp Output: approx. 5V (positive-going).

Trigger System

Modes: Automatic or Normal Triggering.
Sources: Ch. 1 or II, alt. 1/11, line, ext.
Slope: positive- or negative-going edge.
Coupling: AC, DC, HF, LF.
Sensitivity: int. 5mm, ext. approx. 0.5V.
Bandwidth: DC to at least 70 MHz.

Bandwidth: DC to at least 70 MHz.
Trigger Action: indicated by LED.
Single Sweep: Single-Reset buttons with LED.
Holdoff Time: 10:1 variable control.

Sweep Delay

Ranges: 7 decade steps 100 ns-0.1s, with variable control 10:1 to 1s.
(Delay time measurable with timebase.)
Modes: normal, search, delayed (LED indic.).
2nd Triggering "after delay": with variable level, pos. or neg. slope, int. or ext., disconnectible to "free run".

Horizontal Deflection (X)

Bandwidth: DC-5MHz (-3dB).
Input via Channel II.
X-Y Phase Shift: <3° up to max. 100kHz.
(Other values see Vertical Deflection.)

Miscellaneous

Cathode-Ray Tube: D14-654 (P31 or P7), rectangular screen with internal graticule.
Total Acceleration Voltage: 14kV.
Trace Rotation: adj. on front panel.
Z-Modulation Input: pos. TTL-level.
Scale Illumination: three-position switch.
Calibrator: square-wave generator 0.2V ± 1%, approx. 1 kHz, for probe compensation.
Regulated Power Supply incl. high voltage.
AC Power Source: 110, 125, 220, 240V.
Line Fluctuation: maximum ± 10%.
Line Frequency: 50 to 60 Hz.
Power Consumption: approx. 42W.
Weight: approx. 10 kg.
Dimensions (mm): **W** 212, **H** 237, **D** 380.
Finish: dark grey. With handle and tilt stand.
Accessories incl.: Manual, 2 probes X10/X1.

Subject to change.

$1595

Exceltronix
Components & Computing Inc.

319 College Street, Toronto, Ontario, Canada M5T 1S2 (416) 921-8941.
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5 to 10 pounds	$16.00	Disk Drives
10 to 20 pounds	$20.00	Printers, Monitors
20 to 30 pounds	$24.00	Systems
Over 30 pounds	please call	?????

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Versadigital Signs

The sign that also talks

Every business needs attention. In today's competitive marketplace you need to get the customers' attention and you need to get your message across - as boldly and as dynamically as possible.

Two versions are available, single and double row. Each row holds up to 21 standard characters and can be expanded to up to 42 characters. The LED (Light Emitting Diode) display is available in red (standard or extra bright), green and yellow. Standard, wide (2", upper and lower case) and bold tall (4", upper case) come with the display. All can be displayed normally or in inverse (black characters on a lit background) image format. You can even program your own characters and graphic symbols. As well as the standard LED display, larger, brighter incandescent light bulb displays can be built to your specifications. All programming features are retained, and the standard LED display is included for ease of programming.

A wide variety of features allow you to catch the public's attention — choose from Wipe-On and Wipe-Off, Spell-On, Flash and Blink, Shift left and right, Scroll up and Down — in any order and at individually selectable speeds.

Up to six different events can be displayed simultaneously within dynamically selectable boundaries. Up to 128 labelled messages can be stored within the units memory for display at any preselected time and date and in any order. 12,288 character memory is standard on the Versadigital Display. This can be expanded to 36,864 with optional external read only memory modules.

Text can be entered through the Display's own keyboard, from an ordinary cassette recorder, from optional external memory modules, or optionally over telephone lines, radio or infra-red link or over AC wiring. A comprehensive set of commands allow complete control over the display's facilities. A powerful word processor type editor lets you easily write, edit, run, save (on cassette) and transmit messages.

Use It Alone . . .

Using the Display's own keyboard, you can enter messages, or modify old ones, any time you wish. You can create messages weeks in advance and store them on cassette for subsequent use.

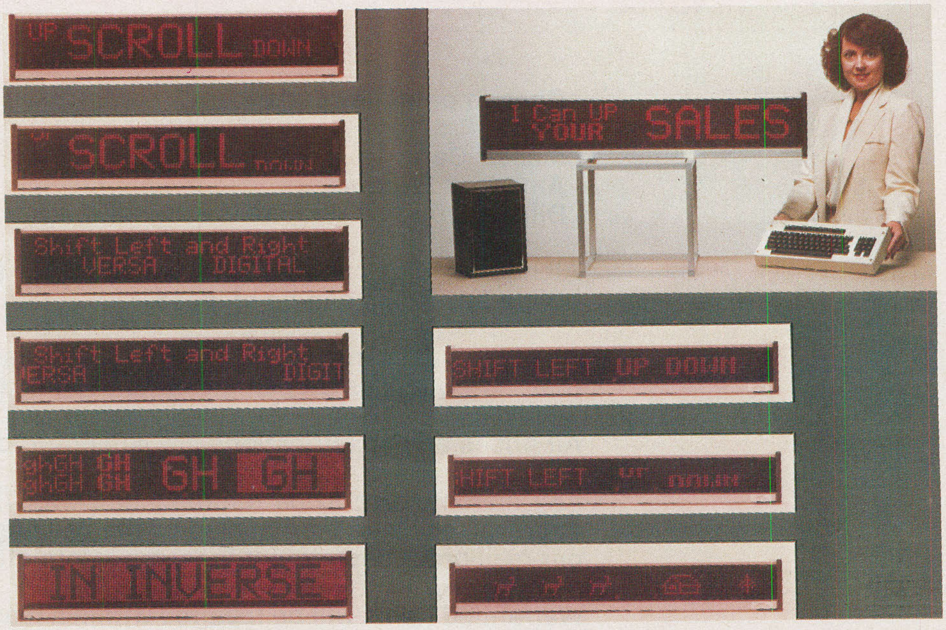
You can program, say, a set of store specials to appear at selected times throughout the day and then just leave it alone. The Display's internal clock does the rest. You can even program it to turn itself off at night and back on in the morning. The Versadigital Display's optional voice capability ensures that your messages will be noticed as they come up.

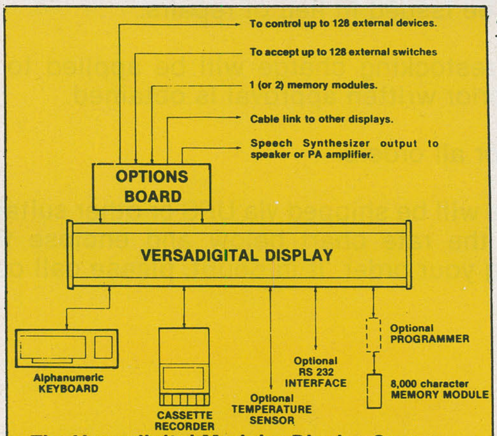
. . . Or Use a Lot Simultaneously

An optional link enables additional displays to echo a single central display, at distances of up to 4,000 feet. You can disperse displays around a bus terminal, shopping plaza or throughout a train and update them all by simply updating one.

Unprecedented Programming Flexibility

Versadigital offers a variety of methods for programming your Display. Aside from standard keyboard and cassette interface, the Display can be programmed (by means of an RS-232 port) via telephone lines, infra-red or radio link or over AC wiring. Ideal for multibranch use as it allows updating across the city, or across the country.





The Versadigital Modular Display System

A revolution in sign technology

Optional Programmable External Memory Modules expand the Display's internal memory and allow preprogramming weeks in advance. Unlike audio cassettes, these require no special reader, but can be plugged directly into the Display. One module can be added without modification, two more plus an options board expand the Versadigital's memory to a whopping 36,864 characters. Modules can be read directly by the Display, or programmed via an optional programmer module. Modules can be programmed weeks in advance and then mailed out to branches for displaying.

The modules are completely re-usable and are erased by a half hour's exposure to ultraviolet light.

The Sign That's Portable

The Versadigital Display can be optionally run from any 12 volt automobile supply. Take it on the road! To outdoor rallies, fairs and other events. Anywhere you can go, you can take the Versadigital Display with you.

The Sign That Can Sell Your Product

Research has shown that digital displays can increase sales by up to 30%. The Versadigital Display virtually assures that figure by increasing the readers' involvement. An optional interface allows up to 128 switches to be connected to the Display, enabling customers to select specific messages without having to wait for the sign to cycle through its repertoire.

The optional External Accessory Interface allows you to write messages that actually point to the product being discussed. At selected points within your message you can program the Display to turn on an external light or a bell. Thus your message might be saying "You won't find these shoes anywhere else . . ." and the Display will then activate a lamp high-lighting the product. Up to 128 external devices can be controlled in this fashion. This feature alone makes the Versadigital Display the most effective sales tool you can have.

The Sign That Protects Your Message

In the event of a power failure, the Versadigital Display's memory back-up keeps the Display's memory intact for six hours. The Display will also keep proper time. With this feature, you can unplug your sign to move it without losing any messages.

We believe that the Versadigital Display is the most advanced digital sign available today. It has all the features and capabilities you'll ever need in an electronic sign, and if it doesn't, tell us, and we can build to your specifications.

Versadigital Technology also manufactures Time and Temperature displays and can build dynamic plaza maps to your specifications. Our extensive engineering experience enables us to design to a wide variety of situations. Whether it is modifying a current product, or designing new equipment, tell us what you need, we can deliver!

VERSADIGITAL TECHNOLOGY INC.

comitant discovery was that flowing the laser gas through the optical cavity at high speed could solve the waste heat problem and greatly increase the power output of the laser. The next step was to invent a way to generate the energy required to operate the laser in an efficient and upwardly scalable manner. The required invention was made in 1967, and consisted of the carbon dioxide gas dynamic laser, or CO_2GDL.

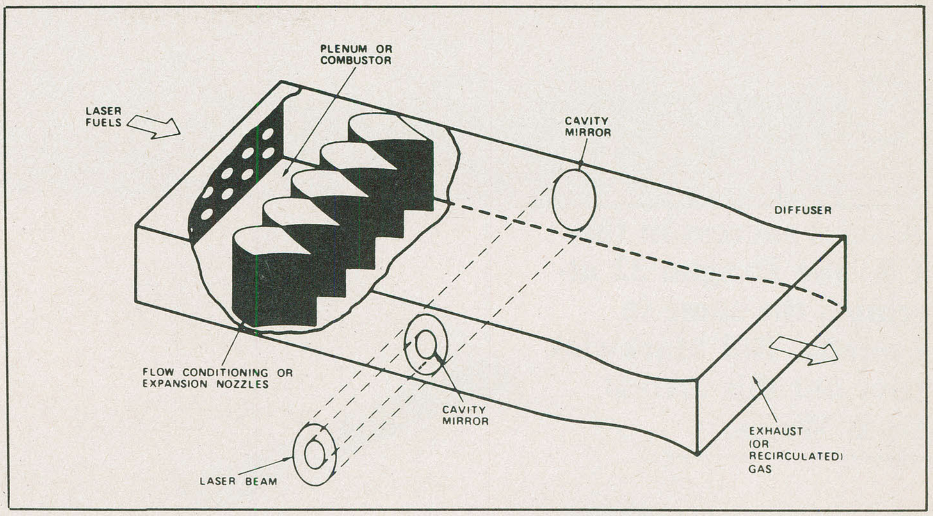
The energy required for operation of the CO_2GDL is generated by combustion of carbon monoxide with an oxidizing agent such as nitrous oxide. This combustion produces energetic molecules of CO_2 capable of releasing photons. This energetic state is maintained by dynamic expansion of the hot gases through a bank of supersonic nozzles; this also provides the conditions of flow necessary for extraction of the photons with good beam quality. The optical energy is extracted from the energetic CO_2 molecules with mirrors looking across the flow field just after the flow leaves the nozzles. The photons extracted move across the flow field, picking up other photons as they go. The photons leave the laser cavity as an intense beam of energy at a wavelength dictated by the type of molecule giving up the energy; 10.6 micrometers since the molecule is CO_2. Subsequently, upwardly scalable lasers include the electric discharge laser, the chemical laser, the excimer laser and the free electron laser.

A laser system is expected to handle a large number of targets even if the targets are coming from all directions. For each "shot" the laser takes, relatively small amounts of fuels are used to generate the beam. Thus, there is the potential for storing a large number of shots per installation (or a large magazine per weapon). Finally, since the beam is steerable by moving mirrors, the laser weapon has the potential to move rapidly from target to target over a wide field of view.

Disadvantages

But simply spitting a laser ray in the direction of a target is not enough. A successful laser engagement occurs when the beam burns through the target surface and destroys a vital component such as its guidance system, or ignites a fuel or warhead. Thus, since the energy is delivered instantaneously, the laser must dwell on the target to destroy the target. Furthermore, jitter of the focussed spot over the target smears the energy in the beam over a larger effective spot size, increasing the time required to damage the target. Thus the beam's control subsystem must hold the beam steady on the target aimpoint. To do this, the target tracking and beam point functions must be especially accurate.

A second difficulty with such a weapons system is the effect the atmosphere has on the laser beam. As a function of the wavelength of the laser energy, the atmosphere absorbs some of the energy being propagated, causing the beam to "bloom" or defocus, and adds the above-mentioned jitter to the beam. Interactions between the high power beam and the atmosphere effectively increase the spot size on target, lowering the peak intensity and thereby increasing the dwell time. The next effect is that for a given range there is a critical power level beyond which intensity on target decreases as the power radiated by the weapon increases. This effect is most pronounced when the line of sight to the target is fixed (as is the case where the attacker is headed directly at the laser and the wind velocity is low). In bad weather or in the presence of clouds or aerosols such as smoke, more of the energy in the laser beam is absorbed, effectively limiting the rage of the laser weapons.



Basic diagram of a high-powered laser

"The separation of fantasy from fact has become increasingly difficult as experts vent opinions without explaining how much is reality."

In the vacuum of space, the laser beam does not have to contend with the degradations caused by the atmosphere, and space has often been referred to as the "natural" environment for laser weapons. In this vacuum, potential applications include anti-satellite, counter-air, and ballistic missile defense. Some have argued that the potential exists to create a damage limiting ballistic missile defense system with space-based laser weapons; in the vacuum of space, one could achieve the very long weapon ranges of operation needed to contend with the vast volume of near earth space. At long ranges, the stressing requirement to point accurately is ameliorated somewhat by the low angular tracking rates required. However, at ranges typical of space engagements, it is necessary to lead the target.

In response to Congressional requests, a report on the subject of space laser weapons was made in May of 1981, and a space laser program approved by the Secreatry of Defense was forwarded to Congress in June of 1982. This plan provides for continuing development of necessary technology and concomitant system effectiveness and mission utility analysis over the next few years, leading to a decision in the later 1980s whether to proceed with an in-orbit demonstration of an integrated battle station for some mission application. Such technology development for the next few years is necessary because of significant uncertainties, not only in the technology for the proposed space battle station itself but also in target damage and vulnerability, potential target hardening, command and control, surveillance and warning, and launch and support.

Development of laser weapon systems had previously hissed and sputtered through the 1960s, dying out in 1971. In 1973, it was determined that the Soviet Union was devoting significant resources to the development of laser beam weapons. Their high energy program, even today, is three to five times the US effort. It began in the mid-1960s, when they commenced pursuing chemical laser development, and later, work on the gas dynamic laser and the electric discharge laser. The Soviets also pursued related technologies such as the development of efficient electrical power sources and the capability to produce high quality

Continued on page 72

Computer Review

A sales success in the UK, the Dragon 32 attempts the same in Canada. Bill Markwick tries out this arrival from Wales.

THE DRAGON IS the national symbol of Wales; the actual animal is a bit rare these days, except for the one that's recently arrived at a large number of department stores and computer retailers. The makers hope it will be as popular as its namesake is scarce.

On unloading the computer from its styrofoam box, you'll find it rather large at about 38 x 33 cm. There's a proper full-size keyboard, and the usual string of connectors around the edges for connecting peripheral equipment. The power pack, which by the way is rivetted shut, is the usual separate lump in the middle of the line cord, and the on/off switch dangles from the cord as well. The reason for this is that they stole the computer's power switch to use for the TV channel-select for the North American version. You can switch the RF output from channel 3 to channel 4; a handy thing if you have an interfering local station on channel 3.

If you prefer a video monitor to a TV set, there's a five-pin DIN socket with video and audio available. You would expect a much better image on a proper monitor, but this isn't the case. The colour output makes for very low contrast on a monitor, and the display is much more readable when a TV is used; the longer persistence of the TV phosphor seems to make everything much clearer. Incidentally, you won't find anything in the manual about connector pinouts; they assume you'll just go and buy all the proper stuff and plug it in. We found the ground pin was the middle one of the DIN, and the video was on the pin at the 9-o'clock position (the one at the end, going clockwise).

On powering it up, you'll be informed that it has a 16K BASIC interpreter by Microsoft. This is good news, as it's one of the most popular BASICs around, and you'll be able to use a lot of the published program listings. When you look the keyboard over, you'll find that the four arrow keys are not cursor keys at all. In fact, it doesn't have any. This is bad news. If you should make a mistake, and catch it right away, there's a backspace key which deletes anything it backs over; that's all, folks, no other cursor control.

Editing

Naturally, you'll want to know what to do in case of a major mistake, especially one embedded in your BASIC program which just took you an hour to type in. Even more bad news. It has the Microsoft EDIT function that you'll find on some other computers as well, surely one of the most awkward ever invented. If you should boo-boo on a computer such as a Commodore, you cursor up to the mistake, correct it, and press RETURN (or ENTER). That's it; if you're nervous, you can type LIST to be sure that the correction has been entered.

On the Dragon, and others using this Microsoft editor, you type EDIT and the line number. The offending line is displayed with the line number repeated below it. As you press the space bar repeatedly, the line appears again character by character. When you come to a part that you don't like, you type a "D" to delete, or an "I" to insert. There are other commands, such as "X" to move the cursor to the end of the line, and "S" to search for specific characters. When you've corrected the mistake, ENTER sends the corrected version to the program.

Now, this function might be useful if they had added it to sensible cursoring and editing, but on its own, it gives you a sense of despair. It's the same sort of frustrating feeling you get when you spend three hours re-assembling a complex appliance, only to find a part left over after tightening the last of seventeen screws.

It's particularly irritating to picture designers in Wales selecting this cumbersome editor because they couldn't be bothered changing it; the idea seems to be that you'll only be running pre-packaged

software and won't need programming functions, which makes the inclusion of a 16K interpreter a puzzle.

Getting Started

The manual starts you off with simple arithmetic and string manipulation to familiarize you with basic BASIC basics. The computer starts you off by not printing characters if you type too fast. The reason for this lies in the keyboard. The contact is made when the key is pressed down for only a tiny part of its travel; during fast typing it's inevitable that several keys will be down at once, and the first key down plugs up the works until it's released. There should be a proper rollover function; a buffer should store the keystrokes and march them out to the computer in a nice orderly way.

Once your fingers get the hang of the keyboard, though, there are a wealth of nifty features provided by the BASIC. It has all the usual functions provided by Microsoft: strings, arrays, easily-used random number generation, loops, and others.

In the text mode, that is, the normal mode available on power-up, the screen is divided into a 32 x 16 grid with each intersection having a number. This provides you with the PRINT@ feature; you can easily specify where you want text printed on the screen. It's like the "tab" feature on a typewriter, but with control of the vertical as well. The character set, by the way, is upper-case only.

More BASIC

In addition to the expected commands, such as FOR-NEXT and GOTO, you can also use RENUM to renumber a program with any number series you'd like. This is handy should you fill up the available line spaces with additions; the RENUM will reset the lines to larger numbers.

When you run the program and bugs appear, you can track them down with the Trace function. This is the same as the Applesoft version, except that you enter TRON for "trace-on". The program will then run, displaying the number of each line it's doing at the moment. Nice for catching those little lapses of logic.

More Hardware

Now that we're right into the programming, let's look for those little touches we all like on computers, like auto-repeat. Press the key down . . . hmmm, no repeat. There must be a separate key, Apple-style. No, there isn't. Maybe it's a Control key function. Let's see . . . where's the control key? There isn't one! What? I'll go through the manual again; those things that look like cursor keys may be control keys . . . Nope, two of them print brackets, one is an exponent function, and the other is the backspace. At least there's a BREAK key to get you out of those endless loops. How about RESET? Ah, there it is, down at the side. I'll just get a loop going here . . . there we are, now press the button. What do you know, it stopped printing and cleared the screen. And it didn't even dump the memory; LIST brought it all home again.

Perifs

Peripherals shouldn't be a problem; there's the usual raft of connectors: a nine-pin power plug, which speaks well for adding things which need voltages other than 5 V; the above-mentioned monitor DIN plug; TV RF; Reset; left and right joystick DINs, a cassette DIN; a mysterious DIN labelled SI/O which isn't mentioned in the manual, but seems to be a hastily-added serial port. There's also a 20-pin Centronics-type printer port and a ROM pack connector, but no memory expansion port as such.

The manual doesn't mention disks, and glosses over printers, but has information on joysticks and cassettes. There is a good section on writing programs to suit these; cassette motors, for instance, can be controlled by MOTOR ON or OFF, and there's a section on how the computer picks up and responds to the joystick positions. Incidentally, the cursor-keys-that-aren't can be made to come to life using the joystick routines.

This last item points out a bit clearly that the Dragon 32 is aimed at the tailor-made software market; the cursor keys appear only under software control.

More Hardware

The Dragon runs under the control of a 6809 CPU addressing 32K of RAM. Like all computer makers, they don't 'fess up that not all of the RAM is available to the user; some of it gets corralled to run the operating system. Sneaky devil that I am, I used the MEM commend to return the fact that there are 24,871 bytes free on power-up. This is a goodly bit of RAM, even for long programs.

As mentioned, you won't find pinouts or wiring diagrams in the manual. In fact, you won't find any technical help whatsoever. The appendices consist only of ASCII codes, graphics stuff, and a memory map. There's a one-page introduction to machine language which refers you to other books on the subject.

Grafs

Graphics can be invoked in either low- or high-resolution modes. The low-res mode is the 32 x 16 text format, and uses block characters for making simple outlines mixed with text. In the hi-res mode, the standard of living increases to 256 x 192 pixels. There are several grades of resolution in between; the finer resolution modes naturally use up more memory. Text is verboten in hi-res unless you design your own character set.

There are nine colours available; the American Microsoft spells it COLOR and the British manual spells it both ways, just like ETI (we're working on a standard; hang in there). There is a LINE command which links any two pixels, and PAINT, which fills any enclosed shape with a specified colour. CIRCLE draws, guess what, circles or parts of circles. The DRAW function is similar to LINE, but joins the co-ordinates specified by a string; it draws much more versatile shapes on the screen.

There isn't room to cover all the varied graphics functions; in this respect, the Dragon is very impressive.

Sounds

Everybody got sound, man; pick up that computer and just, like, blow. Well, sort of. After typing in a quarter page of symbols, we got it to buzz out "Clementine" ("found a pea-nut, found a peaaaa-nut . . ."). There are two ways of getting toots and beeps out of the Dragon. One is the PLAY command. This one takes the output of the tone generator and nicely divides it up for you into an approximation of the tempered scale. You can enter note names rather than numbers, and specify which of five octaves you want. There are also sub-commands for length, tempo and volume. There's only one tone generator, so no fair asking for chords. The quality of the note produced is full of harmonics that don't sound properly related, kind of an electronic flatulence. Most small computers sound like this.

The Dragon is being advertised by a local dealer as having "speech capability". It won't do any speech as it is; an external program would be required.

Summary

On the plus side, you get lots of memory and a very comprehensive BASIC, good graphics capabilities and a sound generator. The computer is well-made, and there is much software available through Dragon dealers on cassettes and ROM packs.

On the negative side, the price tag of $399 puts it in the same league as machines like the Commodore 64 (allowing for Commodore's package-deal pricing) or the Spectravideo SV318. These machines give you a decent editor and proper cursor control, have more I/O ports, more sophisticated sound generation, and control keys. You might argue that the SV318 has rubber keys, but the full keyboard on the Dragon is also a bit difficult to get used to if you type rapidly. The manual included with the Dragon is certainly a good one as far as Microsoft BASIC goes, but lacks the technical support you get with other documentation. You never know when you'll want to add a non-Dragon peripheral or cable, and it's nice to know those pinouts.

The Dragon 32 is said to be one of the best-selling computers in the UK. This may speak more for aggressive marketing than it does for the computer itself. While not exactly a bow-wow, we had expected to find more features on a computer in this price range.

ETI

Quick Reference

Dragon 32
Mfg: Dragon Data, Wales, UK
Price: $399
CPU: 6809
RAM: 32K
User RAM: 25K
ROM: 16K Microsoft BASIC
Screen: 32 x 16 text, various graphics modes up to 256 x 192
Connectors: TV, audio/video DIN, 2 joysticks, cassette, serial port, Centronics parallel printer port.
Other Features: Comprehensive BASIC and graphics, sound generator.

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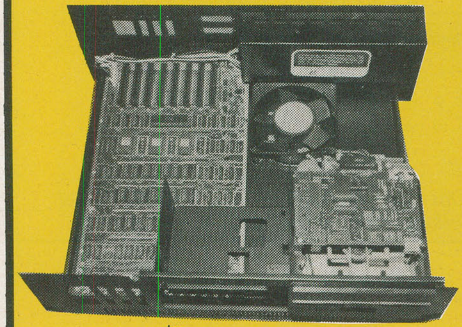

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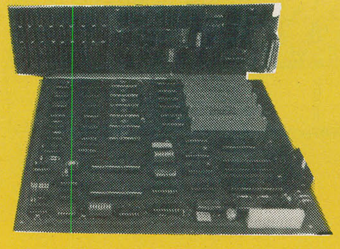

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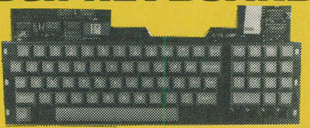

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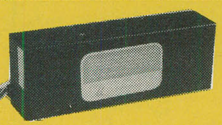

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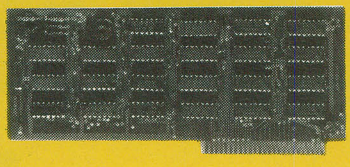

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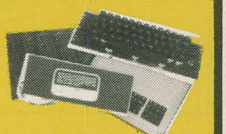

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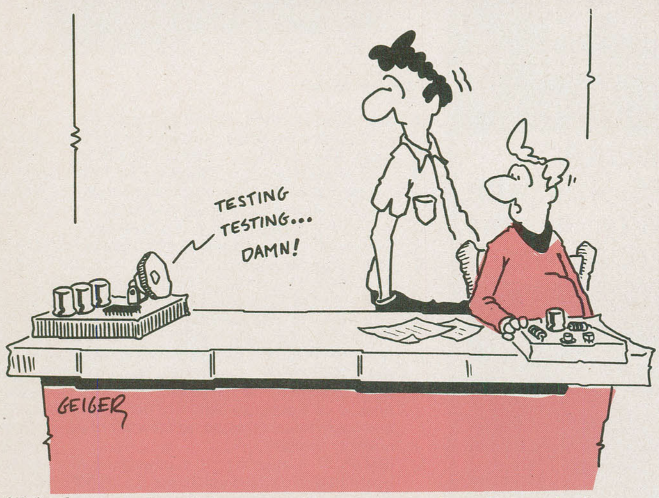
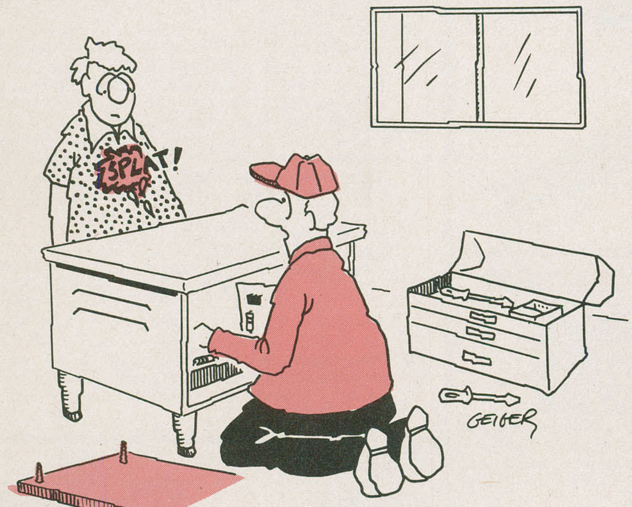


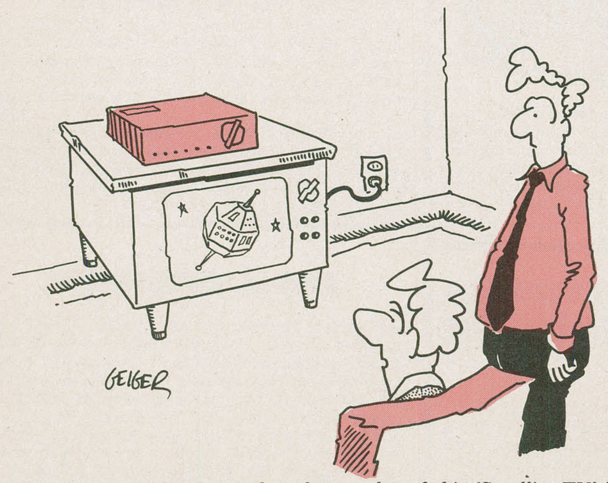
"It's that reverb unit I was working on yesterday - I thought it was broken."

"I paid forty bucks for this video game called 'Fool's Delight', and there's nothing but a blank screen."

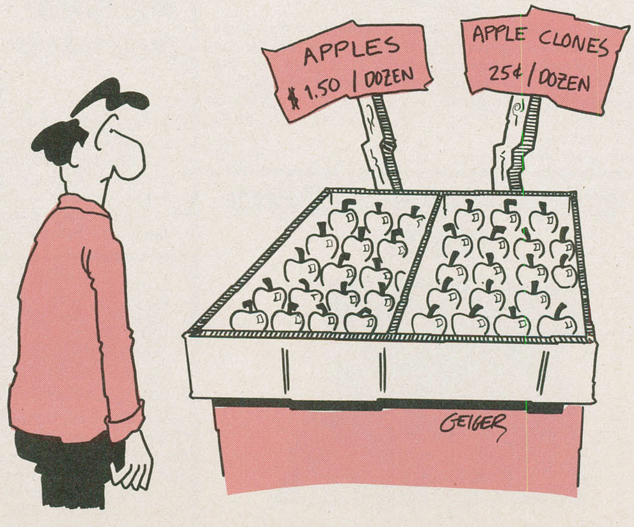


"Colorburst seems okay."

"An anti-glare screen for the CRT costs forty dollars, and sunglasses cost two dollars."



"I don't know about you, but the novelty of this 'Satellite TV' is fast wearing off on me."



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Compressor/Limiter

When it comes to compressing those troublesome signals that are prone to overload, this ETI project really does the job.

COMPRESSORS and limiters have many uses in professional recording and broadcasting, and they can also be pretty useful to the amateur. Perhaps the single most important use is for overload protection: the limiter is set up so as to remain inactive until a signal occurs which would overload following circuits (perhaps a radio transmitter or power amplifier), at which point gain reduction cuts in and, without being very noticeable about it, the unit prevents blown fuses, gross distortion or worse.

The circuit described here has been designed to be capable of both the compressing and limiting actions – it all depends on the signal size you apply and the gains you set in the circuit. With the component values shown, the specification of this unit is very similar to devices currently in use in stereo radio broadcasting.

On the Attack

In this circuit the attack has been made very fast indeed, the time constant being 220 microseconds: hence the time taken for the limiter to react fully to an overload above the limiting threshold is approximately 500 microseconds. The decay time was chosen to be 330 milliseconds; hence

How it Works

The left and right channels of the unit are identical, so this description will be confined to the left-hand channel.

IC1 forms a buffer, and its gain is adjustable by PR1 so that it can be used to set the input sensitivity. The variable gain cell is made up from IC2 and IC7a and their associated components. The configuration used is slightly unusual: IC2 forms a conventional inverting amplifier, its gain being determined by R_{FB} R_{IN} in the usual way. However, while R_{IN} is simply R2, R_{FB} is made up from R4 and IC7a which, as an operational transconductance amplifier, can be used as acurrent-controlled resistor. With the addition of a voltage-to-current converter to drive the control input of the LM13600, a complete VCA is formed which will produce a gain inversely proportional to the control voltage.

The first stage of the gain-control side chain is a full-wave rectifier made up from IC3a and IC6a. Q1 boosts the output current drive capability of the rectifier in order to produce a fast attack characteristic when charging C11.

From C11 onwards until the final voltage-to-current converters for the VCA, the two side chains are combined into one channel, the highest of the left or right input signals being registered on C11. In this way stereo ganging is achieved, and this prevents the stereo image from wandering from side to side during gain reduction (if the overload signal is in one channel only). The adjustment of the decay time and limiting threshold for both left and right channels is achieved easily and equally by R32 and PR5. IC8b is used as a high impedance buffer for the control voltage held on C11, which is discharged by R31. The output of this buffer is fed to PR5, which controls the side chain gain and hence the limiting threshold.

The only problem with the particular VCA configuration chosen is that should the control voltage (and hence control current being fed to IC7a) fall to zero, the gain of the VCA will increase to the open-loop gain of IC2, probably resulting in the VCA output reaching one of the supply raisl (as is usually the case when an IC amplifier loses its feedback). In order to prevent this from happening, the control voltage Vc is prevented from going below OV5 by zener ZD1 and preset PR6. Thus the higher of either V_{MIN} or the output of PR5 is passed viaD11 or D12 to the law-shaping amplifier IC8a.

The diode D13 and resistors R35, 36 are configured to make up for the voltage drop across D11 and D12, and maintain a tight compression ratio, typically 10:1. The output of the shaping amplifier provides a low source impedance to drive the voltage-to-current converter IC9a and Q3 (note that the left and right channels split again at this point).

TABLE 1

Measured performance of the prototype.

Gain:	0 dB (adjustable)
Bandwidth (3 dB points):	10 Hz and 30 kHz approximately
Input impedance:	22k
Output impedance:	100R
Limiting threshold:	0 dB (adjustable)
Compression ratio for signals exceeding threshold:	10:1

Crosstalk with non-speaking channel terminated with 600R (left-to-right or right-to-left):

100 Hz	1 kHz	10 kHz	20 kHz
-70 dB	-70 dB	-68 dB	-65 dB

Noise with input terminated as above: -70 dB
(this is the gain required to make noise at the output peak to 0 dB on a standard broadcast peak program meter, ie this is the peak noise. Should a measurement be made with an RMS reading meter, this measurement may improve by as much as 6 dB).

Control voltage breakthrough onto non-speaking channel with 20 dB of gain reduction occurring on the other channel:

100 Hz	1 kHz
-68 dB	-68 dB

Tracking between channels during gain reduction: better than 0.3 dB

Distortion at 1 kHz:

Input	Output	Distortion
-8 dB	-8 dB	-66 dB (.1%)
0 dB	-1 dB	-60 dB (.1%)
+10 dB	0 dB	-58 dB (.13%)

Distortion at 100 Hz:

Input	Output	Distortion
-8 dB	-8 dB	-58 dB (.3%)
0 dB	-1 dB	-45 dB (.6%)
+10 dB	0 dB	-38 dB (1.3%)

NB. These figures for 100 Hz distortion were measured with a recovery time constant of 100 milliseconds (total recovery time approximately 220 milliseconds), hence a certain amount of distortion due to the compression of individual waveforms is to be expected. Increasin the recovery time constant as in the final design will improve the low frequency distortion measurements, until for long recovery times (greater than 3 seconds) they will approach the values obtained for 1 kHz.

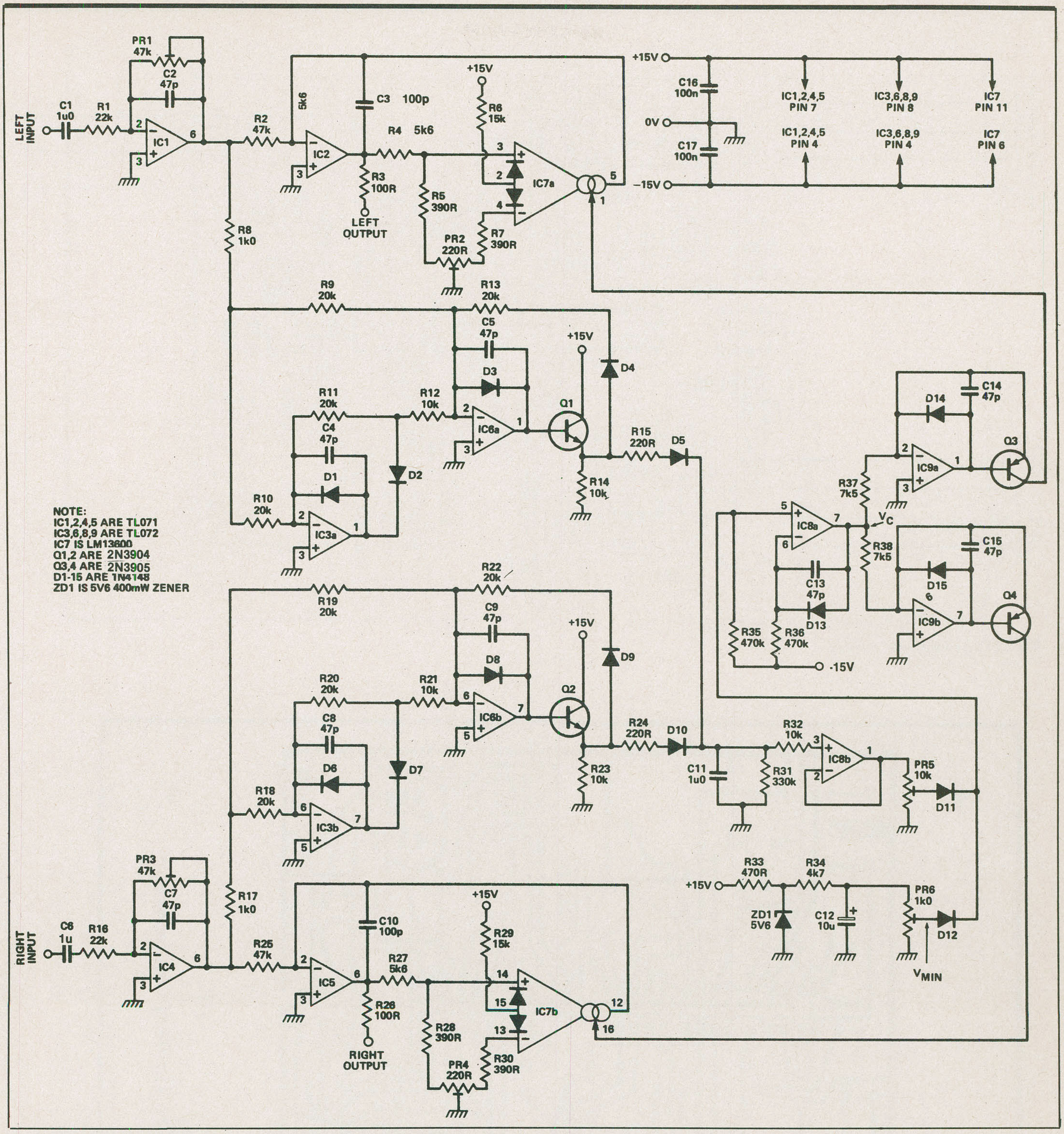

Fig 1. The schematic diagram of the stereo Compressor/Limiter.

full recovery takes place approximately 700 milliseconds after the overload has been removed from the input. This recovery time was chosen after much subjective assessment, and is the fastest possible without undue distortion of low frequencies (this being a common problem in all compressor/limiters). However, as this is a simple one-resistor adjustment it is easy to experiment and find the best compromise for different uses.

Shaping Up

The need for the shaping amplifier built around 1C8a arises because the side chain is, like most professional designs, an open loop system deriving its input from the incoming program material, not from the VCA output. This has the advantage that the limiting threshold and other dynamic characteristics may be altered easily.

Before installing the VCA ICs and powering up, it would be wise to check the side chain components; a fault which resulted in no control current to IC7 could damage the LM13600. Remove ICs 2 and 5; apply power and measure the current into pins 1 and 16 of IC7. This should read in the region of 65 uA. Vmin should be OV5, and there should be no signal present.

The setting up procedure is very simple indeed. PR6 should be adjusted so that Vc is held at OV5 with no input

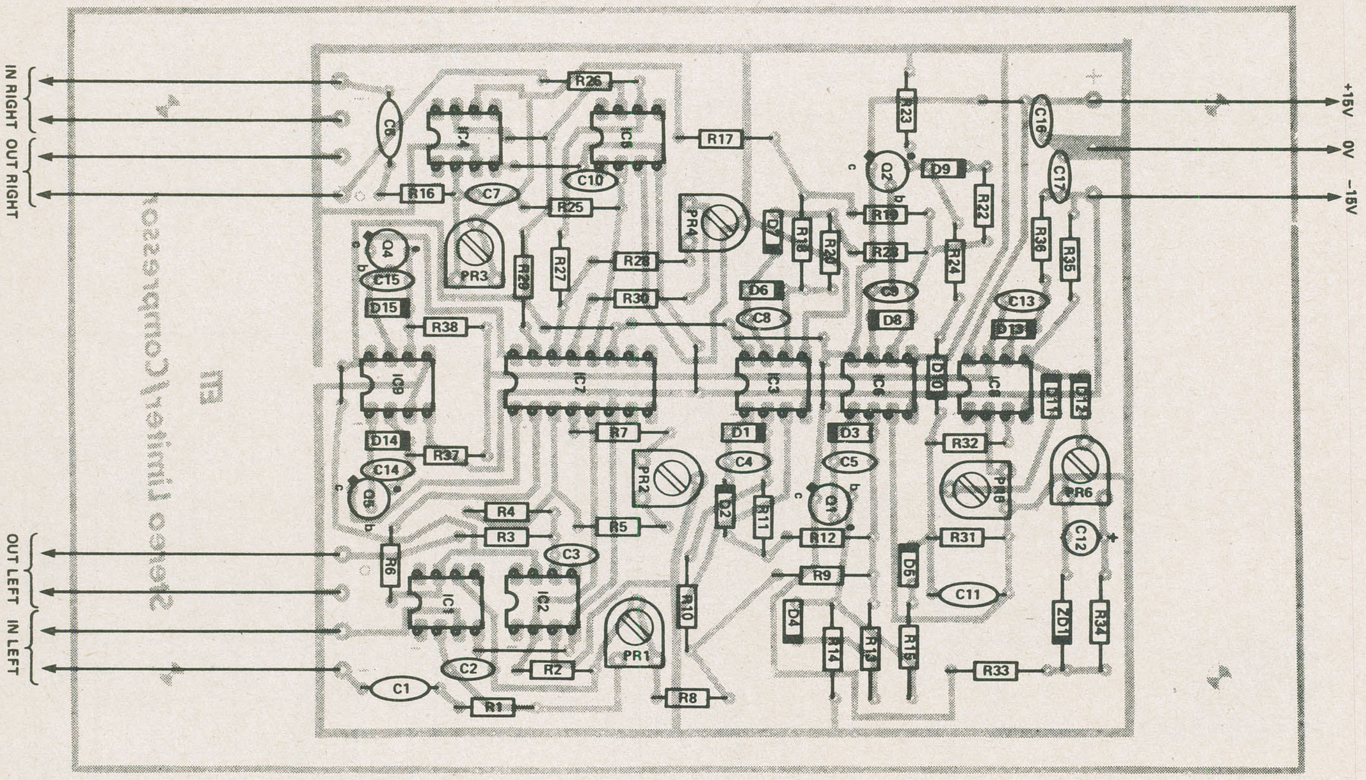

Fig 2. The component overlay.

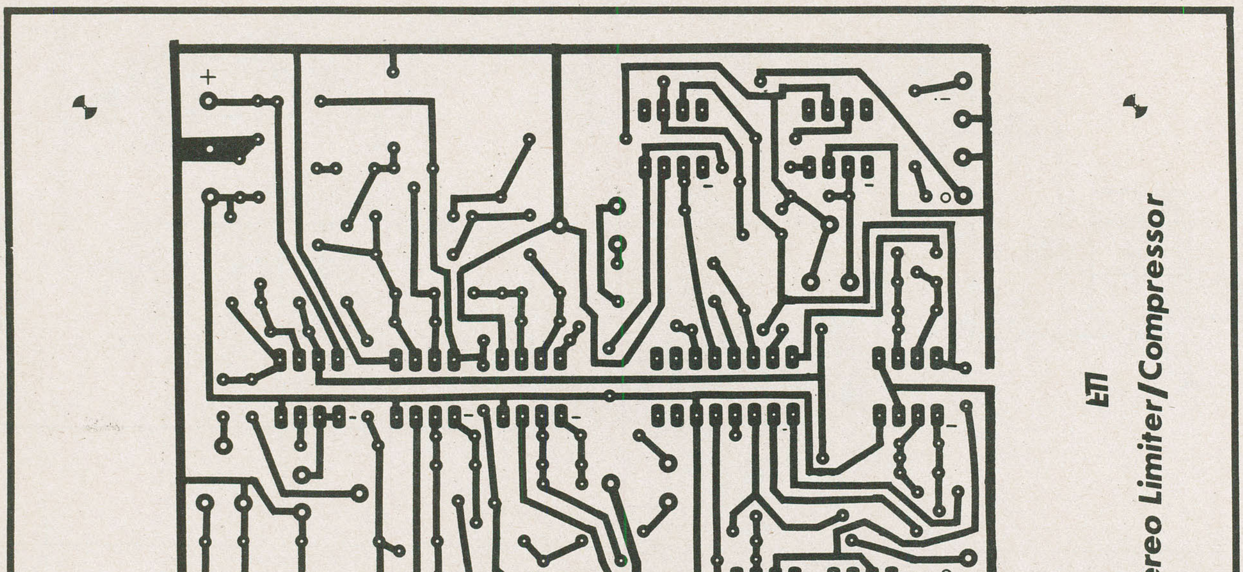

Fig 3. The printed circuit layout, foil side.

signal. PR1 and PR3 should then be adjusted to give the required gain from each channel (usually 0 dB). That concludes the static setting-up, except for PR2 and PR4 which should be adjusted for zero offset at the output of the VCA. This ensures minimal control voltage breakthrough onto the audio output during gain reduction.

To set the compression threshold, a high level signal (for example, +10 dB) should be applied to the input, and PR5 adjusted to give 0 dB at the limiter output.

If the above sequence is followed, the limiter will act as a normal unity-gain amplifier for all signals below 0 dB, and will reduce the gain of all signals above this threshold such that the output at no time exceeds 0 dB. Should the limiting threshold need to be reduced to, say, -10 dB to be more compatible with domestic equipment, then all that is required is an increase in the gain of the side channel by that amount. This is easily achieved by increasing R13 and R22 from 20k to, say, 47k. Should an indication of gain reduction be required, this is easily provided by buffering off Vc, the control voltage, by 1k0 or so to prevent any fault on the metering equipment affecting the operation of the limiter (or this metering equipment could consist of a simple bargraph driver and LEDs).

Parts List

Resistors (all ¼W, 5%)	
R1,16	22k
R2,25	47k
R3,26	100R
R4,27	5k6
R5,7,28,30	390R
R6,29	15k
R8,17	1k0
R9-11,13, 18-20,22	20k
R12,14,21, 23,32	10k
R15,24	220R
R31	330k
R33	470R
R34	4k7
R35,36	470k
R37,38	7k5
Potentionmeters	
PR1,3	47k miniature horizontal trim pot
PR2,4	220R miniature horizontal trim pot
PR5	10k miniature horizontal preset
PR6	1k0 miniature horizontal preset
Capacitors	
C1,6,11	1u0 polycarbonate
C2,4,5,7-9, 13-15	47pF ceramic
C3,10	100pF ceramic
C12	10uF 16 V tantalum
C16,17	100nF polycarbonate or ceramic
Semiconductors	
IC1,2,4,5	TL071
IC3,6,8,9	TL072
IC7	LM13600 (National)
Q1,2	2N3904
Q3,4	2N3905
D1-15	1N4148
ZD1	5V6 400 mW zener
PCB, suitable case, etc.	

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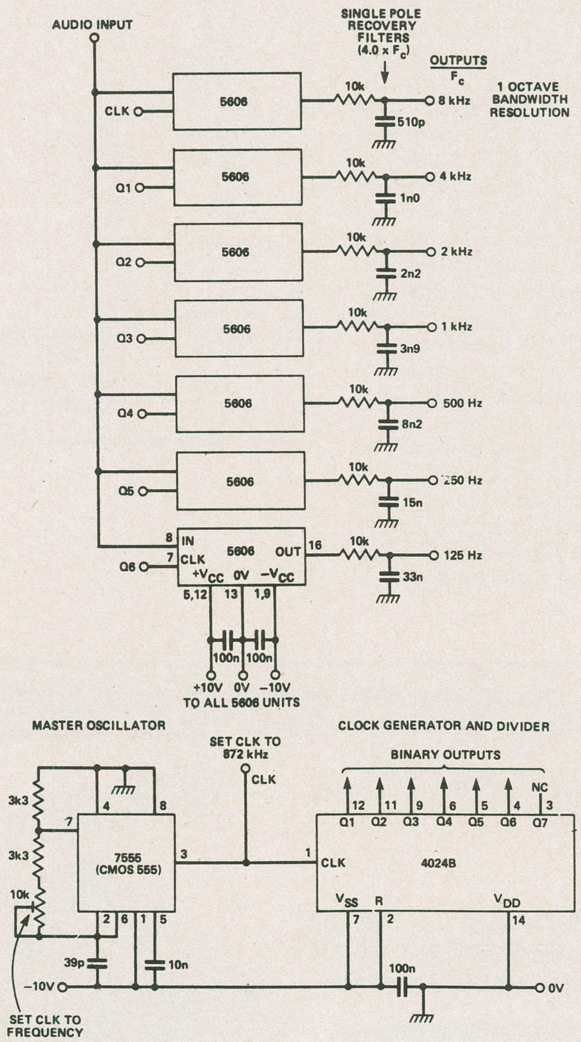
Designer's Notebook
Switch Capacitor Filters Part 2

Last month, we looked at some of the new switched capacitor ICs. This month, Tim Orr gets down to some circuits using them.

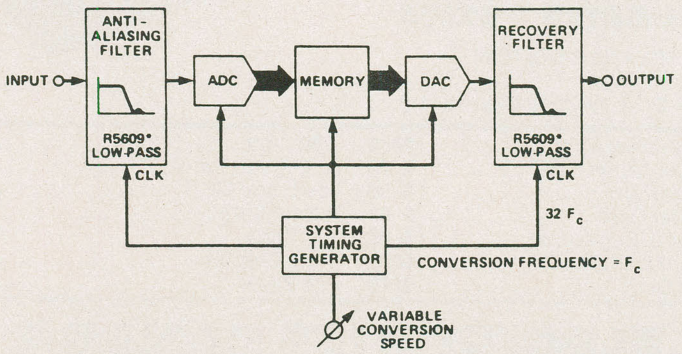
Seven-Octave Audio Analyser

The R5606 is a single octave filter. Each R5606 is clocked with a square wave generated by a seven-stage binary divider, so that successive filter break-points are spaced at exactly one octave intervals. The resulting circuit is very simple and may be used as a real-time audio analyser or as an audio equalizer with a steep filter roll-off. Half-octave or even ⅓ octave resolution could be obtained by using the R5605 or the R5604 respectively. The output signal is filtered by a simple single-pole low-pass filter to remove the effects of the sampling and the residual clock breakthrough. A simple anti-aliasing filter can also be used at the input to each filter, but this may not be considered necessary. A dynamic range of about 76 dB per channel should be obtained.



Audio Converter With Tracking Filter

The R5609 is a steep low-pass filter which can be used as an anti-aliasing filter and recovery filter in an audio converter, such as digital delay line. If the clock for the filter is derived from the system clock and the A-to-D converter, then the low-pass filter frequency will track any changes in the conversion speed.



* The R5609 has a rolloff slope of 100 dB/octave.

System bandwidth $= \frac{32 \times F_c}{100} = 0.32\ F_c$

Maximum theoretical bandwidth, as predicted by the sampling theorum = 0.5 F_c

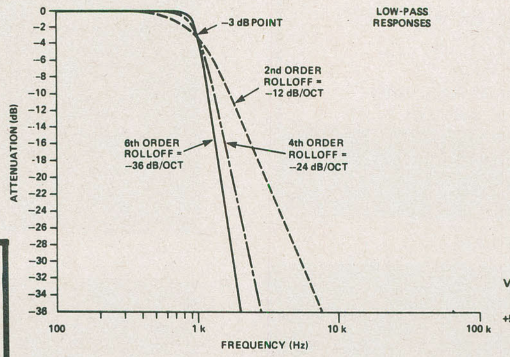
Low-Pass Response Using the MF10

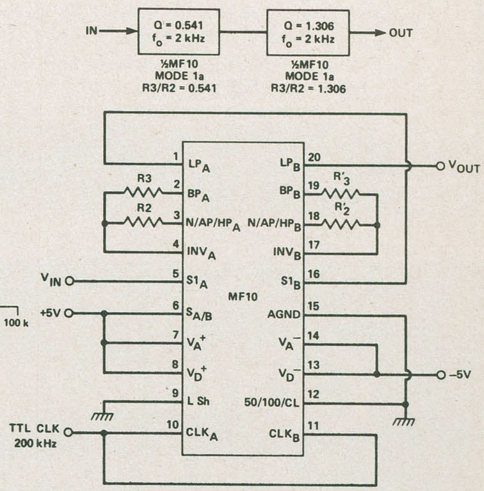
The frequency responses of second, fourth and sixth order maximally-flat low-pass filters are shown in the graph. These can be realized by cascading second order low-pass filter sections together. The table shows the break frequencies and Q factors for both maximally flat (Butterworth) and 3 dB ripple (Chebychev) responses. The maximally flat responses are easy to realize because all stages use the same clock frequency. The 3 dB ripple response requires awkward clock frequencies. A simple design example will illustrate how to use the filter.

The figure shows a design for a fourth-order 2 kHz maximally-flat low-pass filter with an oferall gain of 1 in the pass band. From the table, the first stage should have a Q of 0.54 and a frequency of 2 kHz, the second stage, a Q of 1.306 and a frequency of 2kH. Mode 1a is the most simple realization of the second order low-pass filter. For the first section let R3 = 10k. Then R2 = 18.48k (15k + 3k6 would do). For the second stage let R2 = 10k, then R3 = 13.06k (9k1 + 3k9 is near enough). Both clock pins can be tied together and driven with a single 200 kHz clock (pin 12 grounded gives a clock-to-filter frequency ratio of 100 to 1).

LOW-PASS FILTER RESPONSE	1st STAGE		2nd STAGE		3rd STAGE	
	f_o	Q	f_o	Q	f_o	Q
2nd ORDER BUTTERWORTH (FLAT RESPONSE)	1.0 F	0.707				
2nd ORDER CHEBYCHEV (3dB RIPPLE)	0.84 F	1.304				
4th ORDER BUTTERWORTH	1.0 F	0.54	1.0 F	1.306		
4th ORDER CHEBYCHEV	0.443 F	1.076	0.95 F	5.58		
6th ORDER BUTTERWORTH	1.0 F	0.518	1.0 F	0.707	1.0 F	1.931
6th ORDER CHEBYCHEV	0.298 F	1.044	0.722 F	3.46	0.975 F	12.78

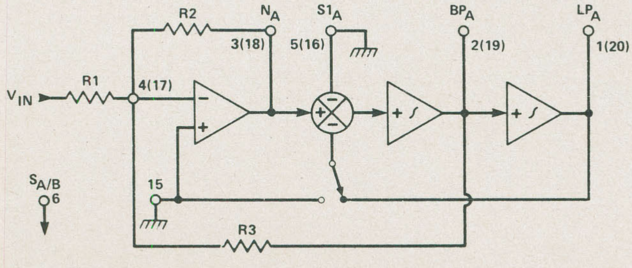
* For the equivalent highpass response, use the same Q factor but use the reciprocal of the frequency multiplier.



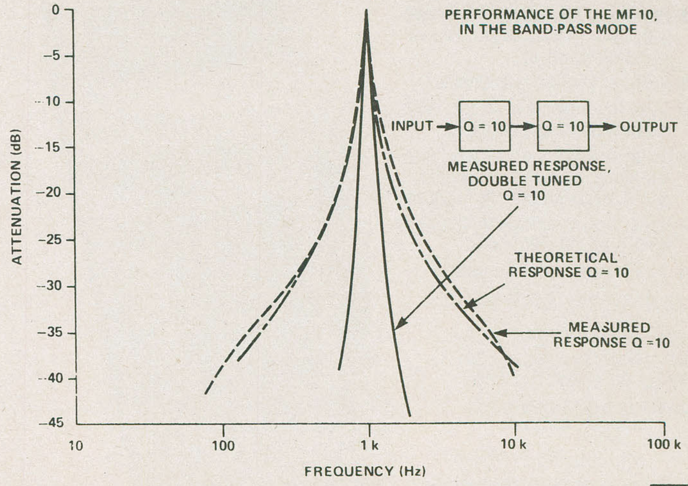


Band-Pass Response Using The MF10

A simple band-pass filter can be constructed using the circuit shown as mode 1 in the first article on switched capacitor ICs, and shown again to jog your memory! For a Q of 10, R3 = 100k, and R2 = 10k. To give the filter unity gain at resonance, R1 = R3 = 100k. The external clock frequency determines the resonant frequency. By cascading two filters with a Q of 10, a very sharp resonance curve is produced as you can see in the graph below. If the Q factor of each filter is increased further, then an even sharper response can be obtained, although this may result in a double peak if the relative resonant frequencies of the two filters deviate.



MODE 1



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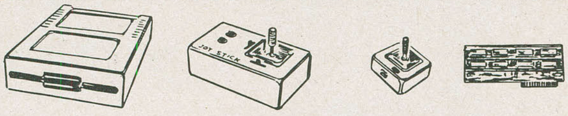

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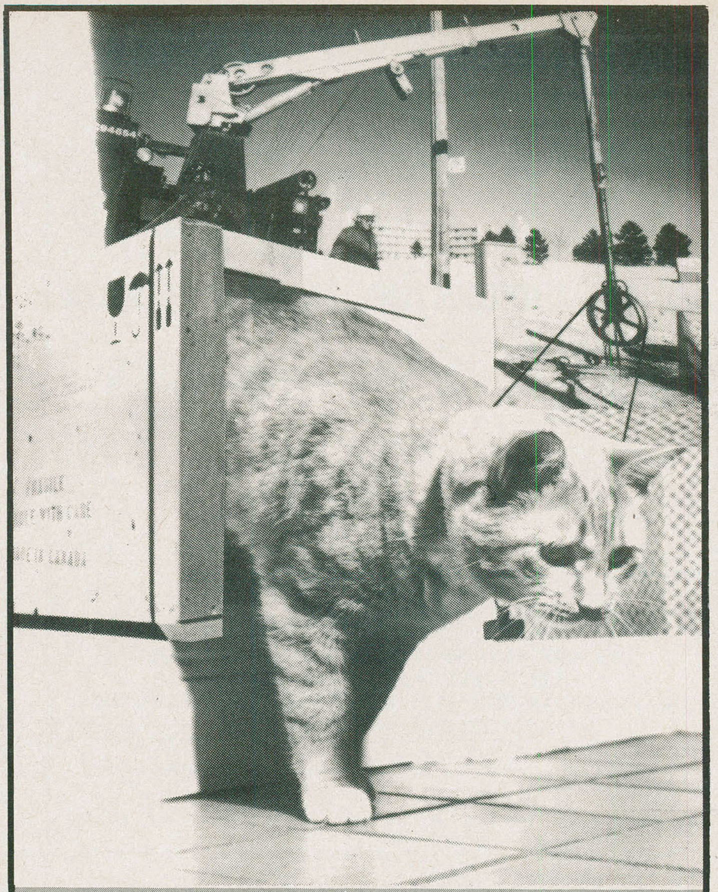

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Designing Micro Systems Part 3

A computer never forgets — provided the information is stored in ROM. Owen Bishop explains the different types and the different applications.

WHEN THE structure of a computer was described in Part 1, 'memory' was considered simply as a section of the circuit responsible for storing information (instructions or data). Part 2 showed how this information is in the form of a sequence of binary code groups, each usually containing eight bits (one byte).

The first point to consider is why a computer needs memory. Although the MPU has internal programming which makes it perform a given operation (such as adding together the contents of two registers) when it receives a machine code instruction on the data bus, there is nothing *inside* it to tell it what operation it is to perform next. The operations it performs automatically are very simple ones. Adding together two single-byte numbers is an example already given. Other examples are incrementing a number by one, decrementing a number by one, transferring the contents of one register to another register, logically ANDing the contents of two registers and so on.

Simple Sums, Complex Sequences

It takes a fairly long sequence of these fundamental operations to perform even the simplest of calculations. For example, to add two numbers which are already stored in memory and to display the result on the monitor screen, the MPU has to:

- Read one number, already stored in memory location X, and store it in its accumulator
- Read the other number, stored in memory location Y, and add it to the number already in the accumulator
- Refer to a table of data already stored in memory to convert this number to its equivalent in the ASCII code. The ASCII code (of which more will be said in a later issue) is a special code used in the majority of computers for representing letters, numbers and punctuation marks in binary form. It takes the MPU several operations to find the ASCII code, and then it has to:
- Find out in which screen position the answer is to be displayed and work out which byte of memory the code group must be stored in to achieve this. Finally it must:
- Transfer the ASCII group along the data bus to that byte of the video memory, so causing the answer to be displayed on the screen in the correct position.

The procedure above may sound complicated but it is a gross oversimplification of what the MPU has to do. For instance, we have assumed that the two numbers are stored as single bytes, but a single byte can take values only from 0 to 255. Most micros store integers as double-bytes (allowing values from -32768 to +32767). They require four bytes for floating-point numbers (seven-figure precision) or eight bytes for 16-figure precision. To add two such numbers together, the MPU must work with the pairs of bytes in turn (one from each number), adding in any carry-over digit from one addition to that of the next higher pair of bytes. It is clear that even the simplest of mathematical operations requires a long sequence of operations by the MPU. Since the MPU can accept and act on only one instruction at a time, the sequence of instructions is set out in a *program,* which is held in *memory.*

ROM And RAM

At this stage we must distinguish between the two kinds of memory that may be used for instructing the MPU. In physical terms, both kinds of memory consists of arrays of integrated circuits, as will be described later. When you type a program into the computer, or when you load a program from a cassette tape or a floppy disk, it is stored away in a part of *Random Access Memory* (RAM for short). We say it is 'written into' RAM. The information is stored in memory cells (bit-storing subcircuits), hundreds of thousands of which go to make up the circuitry of each RAM IC. With RAM you can, if you wish, supply the MPU with a different program every time the computer is used. When a program is run the MPU 'reads' the program from RAM. When you switch off the computer, or type NEW, the program is lost. RAM will be the subject of next month's article but, to sum up its main features, we can say its contents may readily be changed, and it loses its contents when the power supply is cut off.

By contrast, the contents of *Read Only Memory* (ROM, for short) cannot be changed or, if changeable, can be altered only as the result of a special procedure, and are not lost when the power supply is cut off. The fact that the contents are not readily changeable is reflected in the name 'Read Only'. In other words, this kind of memory is intended only (or primarily) to be read from, not to be written into.

Kinds Of ROM

Obviously, there must be a way of writing instructions into ROM, otherwise it would contain no instructions and would be totally useless. There are several different types of ROM with different ways of writing instructions into them. To begin with we will look at the type known as the *mask-programmed* ROM.

Each memory cell (each bit) is programmed at the manufacturing stage. Typically, the cell consists of a transistor with its gate either connected to ground or open-circuit. A connection to ground means that the output from the cell is 1; open-circuit gives an output 0. Before the ROM is made, the program which is to be stored in it is very carefully tested to ensure that it is free from error. The masks used for making and linking the components on the slice of silicon are drawn out accordingly. Cells which are to store a 1 have the gate of the transistor grounded. When the ROM is in use and the MPU addresses a particular cell by applying the appropriate combination of voltages to the address terminals of the ROM IC, the cell's output is gated to one of the data lines. This output may then be read by the MPU. Thus the program is permanently built into the structure of the IC and cannot be altered after manufacture.

High Volume Equals Low Cost

As might be expected, this procedure is an expensive one, due to the high cost of preparing the special masks. Only if hundreds or thousands of ROMs are to be manufactured with exactly the same program does the cost fall to a reasonable level. This is the type of ROM generally used for holding the monitor program of a computer and perhaps a resident language, as explained later. Mask-programmed ROMs are made with capacities between 1 kilobyte and 8 kilobytes.

The advantage of the mask-programmed ROM is that once the program has been finalized, it is possible to manufacture identically programmed ROMs in large quantities very cheaply. For prototyping and for applications in which it is

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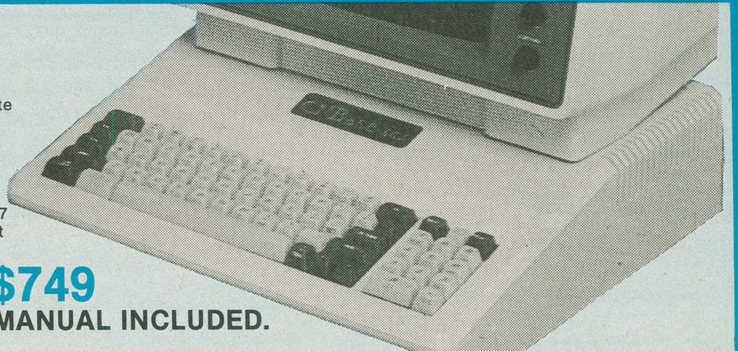

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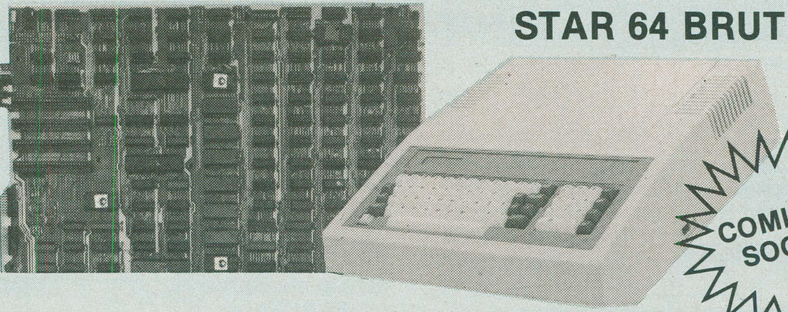

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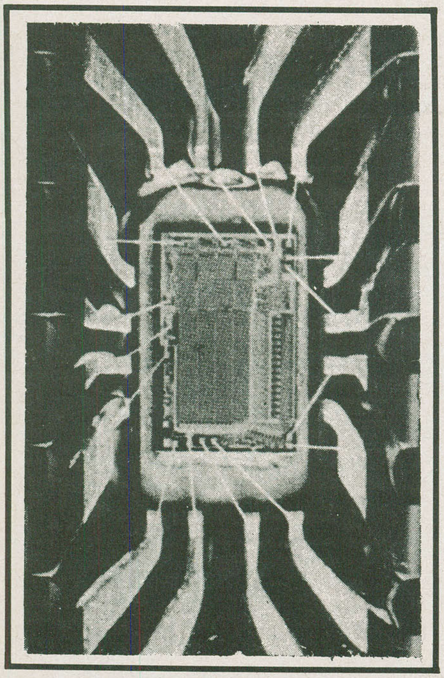
known that only a few ROMs with a given program are likely to be required, we need a ROM that does not depend on mass-production for cheapness. For this purpose we use a different type of IC, known as a programmable ROM, or PROM for short. There are several kinds of PROMs, as will now be described.

Fusible-link PROMs

In a typical version of this kind of PROM the gate of the transistor of each cell is joined to ground by a fusible link. This is a connection which can be destroyed by passing a high current through it. To begin with, all transistor gates are grounded so all the cells in the PROM are set with output 1. When a particular cell is addressed by putting the appropriate combination of inputs on the address lines of the IC and a high voltage is applied to a special terminal of the IC, the link is 'blown'. From then on, that cell gives a 0 output when addressed. Fusible-link PROMs are usually programmed by special electronic PROM programmers which may operate under the control of a computer. The controlling computer holds the program which is to be written into the PROM and coordinates the processes of applying address and 'blowing' the links. Once the PROM has been programmed it can not be reprogrammed, for it is possible only to convert 1 to 0, but not 0 to 1. If only a part of it has been programmed, the remainder still being all 1s, the remainder can be programmed on a later occasion. An example of a fusible-link PROM is the Intel 3624, which stores 512 bytes (½K).



A photomicrograph of a typical mask-programmed ROM chip.

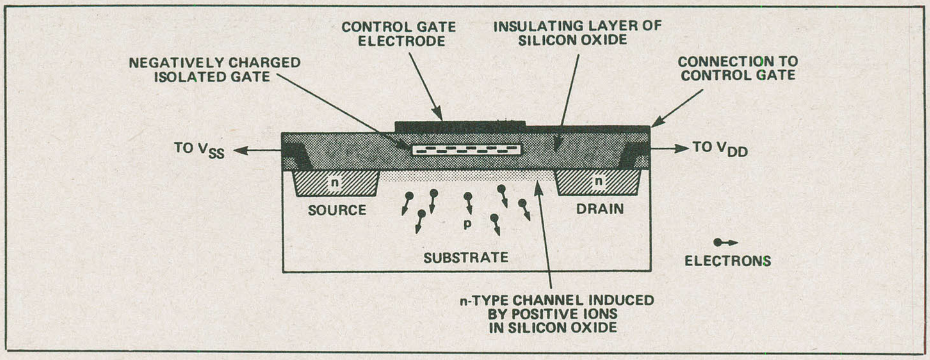


Fig. 1 Diagram of a memory cell in a UV-erasable EPROM. The gate is an N-channel depletion-type MOSFET; here the gate is shown with its negative charge depleting the N-type channel by repelling the electrons in it.

The Ubiquitous EPROM

An erasable PROM can be erased and reprogrammed. The most frequently used EPROM is that which is erased by exposing the chip to ultraviolet light. You can recognize this kind of IC by the window of quartz, through which the chip itself can just about be distinguished as a greyish object about 4 or 5 mm square. Quartz must be used rather than glass, since glass is not transparent to ultraviolet radiation. The UV-erasable EPROM stores information by making use of the extremely high electrical insulation properties of silcon oxide. Insulating layers can be readily formed on the surface of the substrate simply by oxidizing it. In each memory cell, the gate of the transistor has a control gate situated close to it, but separated by an insulating layer (Fig. 1). The gate itself is left unconnected and floats with whatever charge it may acquire.

After manufacture, the gate has no charge, so each cell gives a '0' output. In programming, a high voltage (about 25 V) is applied to the control gate (Fig. 2). Some electrons in the control gate gain sufficient energy to cross the insulating layer and charge the gate of the transistor. Once the gate has been charged, the charge remains for decades, and the cell gives a '1' output. The only way of rapidly removing the charge is to expose the gate to a highly energetic radiation, such as short-wave ultraviolet radiation. This is making use of the photoelectric effect.

A Wavelength That Wipes

The amount of energy carried by a photon of radiation depends on its wavelength; the shorter the wavelength, the greater the energy. In the UV range, only short-wave UV photons carry enough energy each to dislodge and electron from the floating gate. Photons of visible light and UV of longer wavelength each carry too little energy so they have no effect whatever. Radiation of shorter wavelength such as X-rays and gamma rays (which are emitted by certain radioactive elements and produced by a nuclear explosion, for example), are also able to erase EPROMs though these radiations are not in normal use for erasing!

After an exposure to short-wave UV lasting a half an hour or more, the gates of all cells on the IC become discharged. The EPROM is then ready to be programmed again. In this way it has a great advantage over the fusible-link PROM and is widely used in microprocessor systems. Although the EPROM has to be removed from the computer and placed in a special EPROM programmer device (which may be under computer control) the programming, erasing and reprogramming of EPROMs is a straight-forward matter. Naturally, it is preferable for the program to be correct to begin with and have no bugs, but if any error is discovered in the program, it can be replaced by a corrected version in an hour or so.

An EPROM is a PROM which is read from most of the time, but which can be written into occasionally. The operation of writing generally takes rather longer than the reading operation. For these reasons some people refer to EPROMs as read-mostly memories (RMMs).

EEROMs And EAROMs

When an EPROM is erased, the exceedingly small size of the memory cells makes it impossible to pick out any one cell or group of cells for treatment. It is necessary to erase the whole EPROM and program it all again. There are other kinds of PROM which can be erased electrically, known as EEROMs and EAROMs. The EEROMs, or electrically erasable ROMS, are similar to EPROMs in that the whole array of cells must be erased, but erasing is achieved by passing a current through the device. EAROMs, or Electrically Alterable ROMs allow us to discharge the gate by a signal applied to the control gate. In this way we can alter any one or more memory cells without affecting the state of the others.

An example of an EAROM is the General Instruments ER3400. Most of

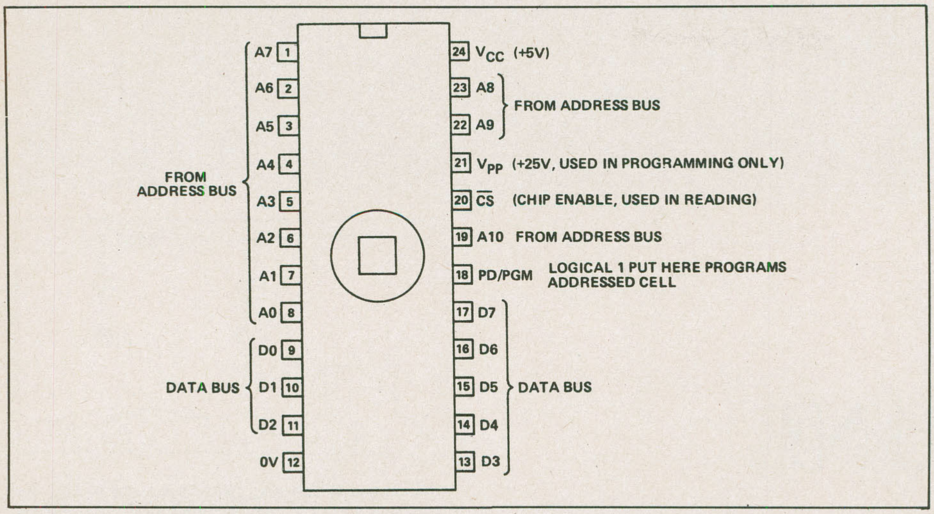


Fig. 2 The pin connections of the 2716, a commonly-used 2K EPROM. During programming the data bus is used to input the required bytes.

these devices employ NMOS transistors, and while they are relatively expensive at present, their cost is beginning to fall and they will soon be very competitive with the UV-erasable ROMs. It takes so little time to erase and reprogram these devices that it is feasible for their programming to be carried out while they are still plugged in to the computer circuit. The usual power supply at +5 V is required for reading, and supplies at other voltages such as -12 V and 30 V are required for programming. We now have the possibility of the computer with appropriate power supplies being able to alter its ROM during the course of running a program; the distinction between ROM and RAM becomes more clouded, though there remains the fact that ROM is permanent (if we want it to be), while RAM is not.

Using ROM

Before going on to discuss how ROM is used, we will discuss why ROM is needed in a computer. Why not just use RAM which is so flexible and can be readily altered at will? To answer this, let us follow the sequence of events when a computer is first switched on. First of all the MPU is reset. This is usually done automatically by a capacitor connected to the reset input, so that the voltage there is held low for a fraction of a second after all other inputs have reached 5 V. In addition, most computers have a reset button to allow manual resetting — this is particularly useful if the computer latches up in some otherwise interminable cycle of operations, as it may well do if there is a bug in the program.

When the reset input is made low, either at power-up or by manual resetting, one of the most important results is that the program counter of the MPU is set to a fixed value. In the Z80 and 8505, the program counter is cleared to address 0000. We must make sure that there is an instruction there for it to execute, otherwise it will never be able to do anything. It will be no good typing instructions at the keyboard or trying to load them from tape or disk. Until the MPU has been told to scan the keyboard for input, or to register the signals coming in at the tape or disk sockets, you will be unable to communicate with it. What it needs as a minimum is a short program to allow it to acquire instructions through the keyboards, or from tape or disk, and store these instructions in RAM (they cannot go in ROM, of course, because ROM cannot be altered). ROM is essential for holding the initializing program which tells the MPU how to get information from the keyboard, tape or disk.

Next month, we look at how a "bootstrap" start-up begins reading data in and out of the CPU.

ETI

CHARLES WHEATSTONE

A multi-talented Victorian scientist and inventor.

by Ian Sinclair

ONE OF THE curious facts about the way we remember Charles Wheatstone is that the measuring system that bears his name, the Wheatstone Bridge, was not, in fact, his invention, nor did he ever lay any claim to it!

Charles Wheatstone was born in 1802 at Gloucester, and seems to have been educated at rather undistinguished schools, because we have no record of his progress in these days. There seems to have been little about his early life to connect him to electrical engineering, and the first impression he made on the world was in 1829, when he invented, of all things, the concertina, that miniature accordian which became the traditional accompaniment of singing sailors in the Victorian era. His interest was at that time intensely devoted to sound waves, and he is credited with the discovery that sound travels faster in glass or metal rods than in air.

In 1834, his research efforts were rewarded by his appointment as Professor of Experimental Philosophy at Kings College, and he continued his researches into sound. It was at this time, incidentally that he coined a new word: "microphone" — though he didn't invent the device. His most important achievement, however, was the measurement of the speed of electric current along cables.

Not many details of the experiment survive, but from the hints that remain, we can reconstruct the method.

Two spark gaps were connected in series, one at the start of a very long length of cable, and the other at the end of the cable. The idea was that when a high voltage (he seems to have used a capacitor charged from a Wimshurst Generator) is applied to one end of the cable, sparks will be produced across both gaps — but the spark at the far end of the cable will occur slightly later than the one at the start.

A Space In Time

The time difference is not large, however. If we assume, as we know now, that the speed of the current wave in the cable is around 200 million metres per second, or 200 m per microsecond, then it takes a 200 m length of cable to cause a delay of only one microsecond. That's not a lot even by today's standards, and it was unimaginably small in those days. Wheatstone used

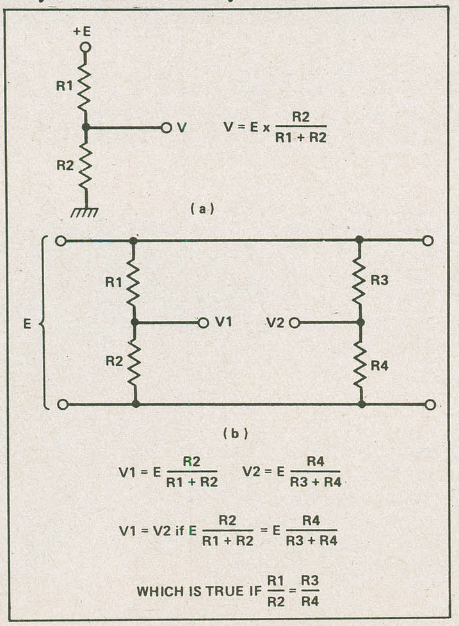


Fig. 1 The 'Wheatstone Bridge'; (a) a simple potential divider; (b) Two dividers connected in a bridge formation.

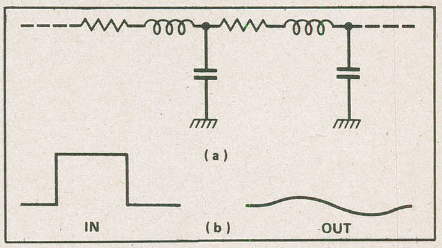


Fig. 2 Cable capers; (a) a long cable can be represented as a set of inductors, capacitors and resistors; (b) their effect is to smooth out pulse waveforms, and this limits the speed of transmission of information.

a method which had already been used to measure the speed of light — a revolving mirror.

The mirror was small, and turned at a very high, steady, measurable speed. The light from the first spark would reflect from the mirror, and so would the light from the second spark — but in the short interval between these sparks, the mirror would have turned so that the reflected images, which would coincide if the mirror had not turned, seemed to separate. The faster the mirror was rotated, the greater was the separation. From the separation of these images, Wheatstone could work out the angle through which the mirror had turned and, knowing the rotating speed, he could also find the time it had taken to cover this angle. This was the time between the two sparks, and from this he could find the speed of the current in the cable.

The method worked (using several kilometres of cable) and Wheatstone was able to announce a value for the speed of electric current in a cable.

This work on the speed of current, however, led Wheatstone to become interested in sending signals through cables, the work which was to occupy him for the rest of his life. He was elected a Fellow of the Royal Society in 1836, at a time when he was working with William Fothergill Cooke on a telegraph system which was to be standard on railways all over the world for more than a century.

Getting The Needle

Wheatstone's aim was to produce a telegraph signalling system which could be used by relatively unskilled operators, but which could handle a lot of information. His first efforts used a 6-wire system which operated three needles (using electromagnets), but this was quickly super-

seded by a 6-wire, 5-needle system.

Each of the five needles was operated by an electromagnet which was connected between one of the five signal wires and the sixth (ground return) wire. Current in one direction would turn the needle clockwise, current in the opposite direction would turn the needle anticlockwise; the needles were spring-loaded to ensure that they returned to the central position when the magnets were not energized, and also that the angle of deflection was proportional to the current passing through in the electromagnet. The principle was that a digit could be selected by pointing a needle at it, and a letter could be selected by pointing two needles so that they intersected. It may look slow and clumsy, but remember that it only needed looking at to receive the message and Morse code, which in any case needs a trained operator, was still a thing of the future.

Wheatstone and Cooke's telegraph system was eagerly adopted by railways all over the world as the railway boom of the 1840-1860 period got under way and, in Britain at least, the name of Wheatstone became almost synonymous with telegraphy. Wheatstone then became deeply immersed in submarine telegraph — the use of underwater cables — and this involved the measurement of large resistance values. The solution that he adopted actually was an invention by Samual Christie to be known as the "Wheatstone Bridge."

The principle, like that of so many good inventions, was simple. If we connect two resistors in series, the voltage across one resistor depends on the ratio of its resistance to the total resistance of the pair. If we use *two* pairs of resistors, then the voltages at their junctions (Figure 1) are equal when the ratios of the resistances are equal. Since this equality, which determines that no current will flow between the points, is easy to detect, and can be detected using very sensitive instruments, it forms a much better system for measuring high-value resistors than the use of Ohm's law. The delightful point about the bridge system is that no *measuring* instrument is needed. All we need is a sensitive galvanometer (which need not be calibrated) to read zero when the voltages are equal, and some resistors of known value.

From Cables To TV

Wheatstone's use of the bridge circuit was another step forward in telegraph technology and led to the first successful transatlantic cable being laid in 1866. This was a remarkable event, not simply because it linked the telegraph systems of two major continents, but because of the other advances which it sparked off. During his work on high resistance measurements, Wheatstone had used the element selenium as a resistor material, and found that its resistance value altered according to the brightness of the light striking it. This discovery set off the research on image transmission that led to TV. In addition, the integration effect of capacitance, inductance and resistance in a long cable (Figure 2) led to the analysis, by Oliver Heaviside, of the effect of capacitance and inductance on signals and particulalry on pulses, in cables — work which was later to be of inestimable value in radar engineering.

Wheatstone was knighted in 1868, a just recognition of his pioneering efforts which covered a huge range of activies not mentioned here. One of these was the stereoscope, which allowed the viewer to see three-dimensional pictures. Another was the use of electromagnets as field magnets in dynamos, a development which changed the dynamo from laboratory device to engineering plant, and led to the large-scale use of electricity (a power source regarded at the time with as much superstitious dread as nuclear power is now).

Wheatstone also amused himself with ciphers, cryptographs and his first love, music. He died in Paris in 1875, too soon to see some of the most exciting results of his work, but with the satisfaction of knowing that he had made a lasting contribution to many fields.

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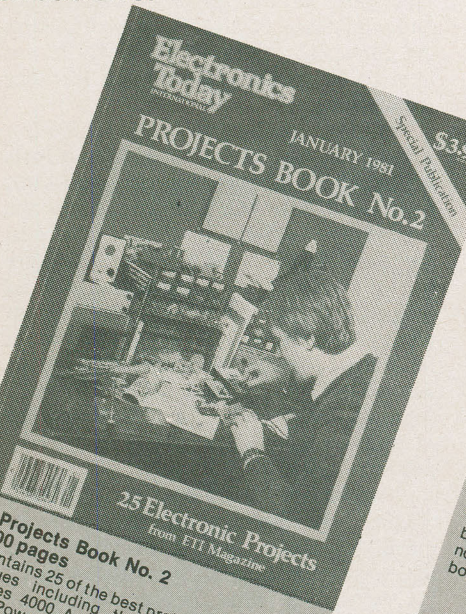

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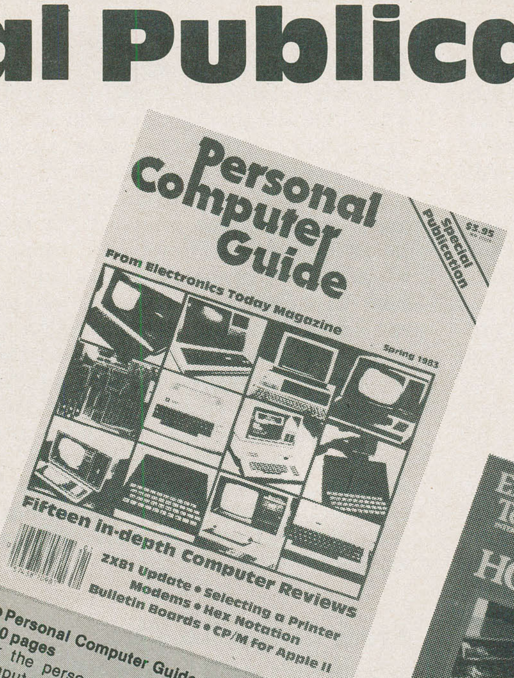

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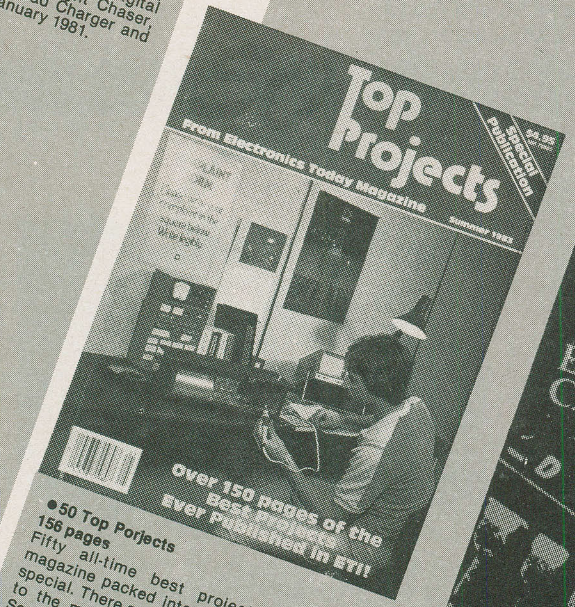

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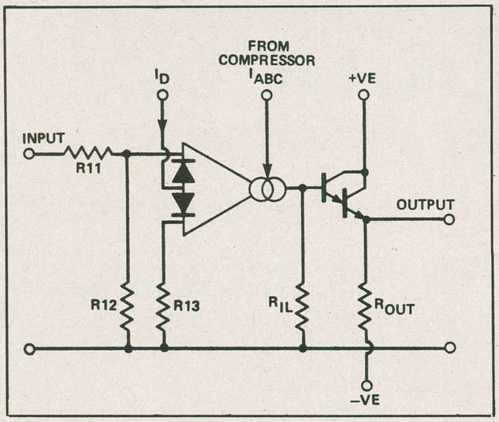


Fig. 4 The LM13600 as an expander.

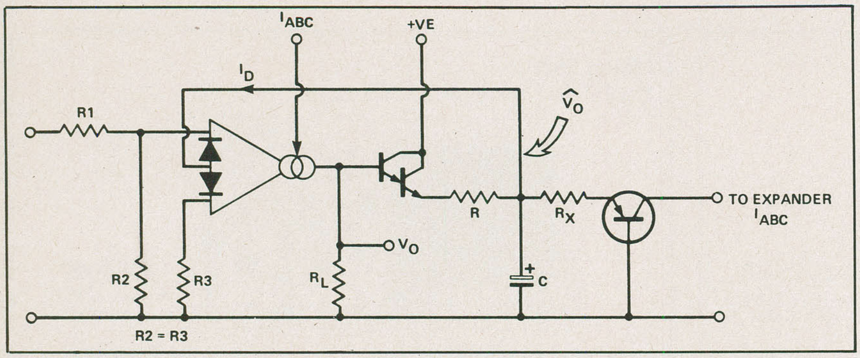


Fig. 5 Here the LM13600 is configured as a compressor.

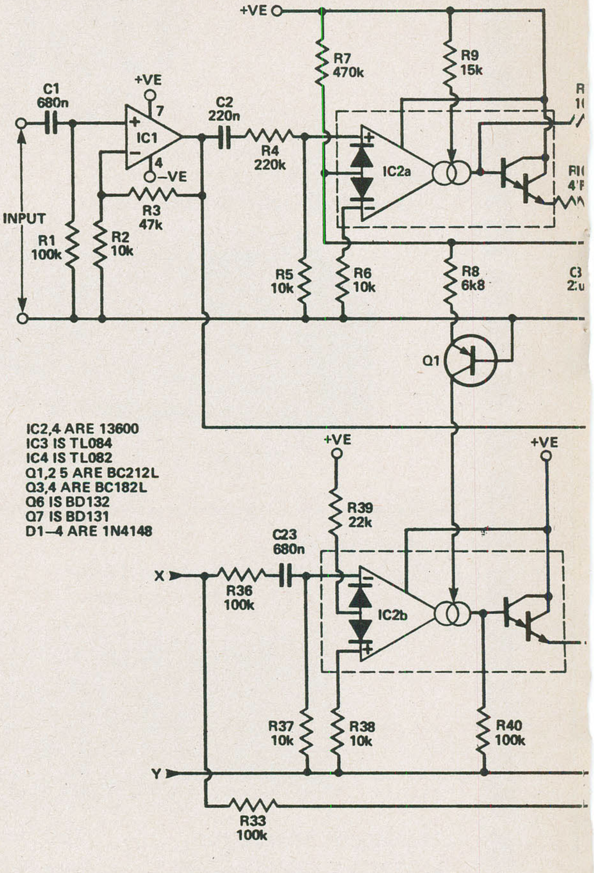
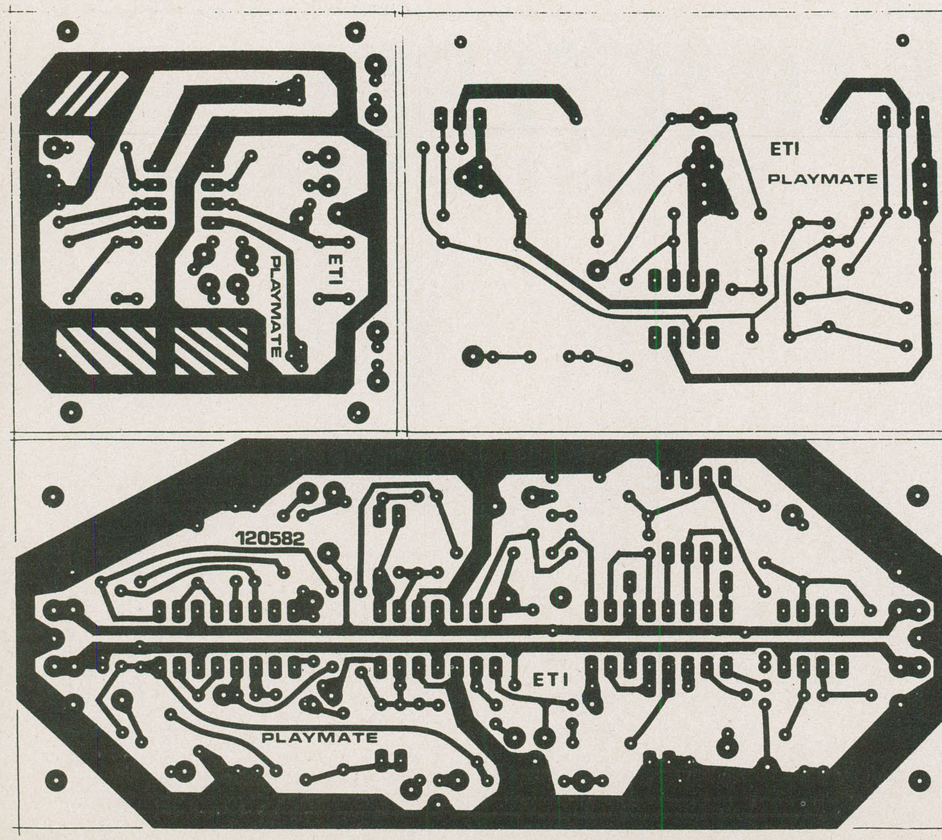


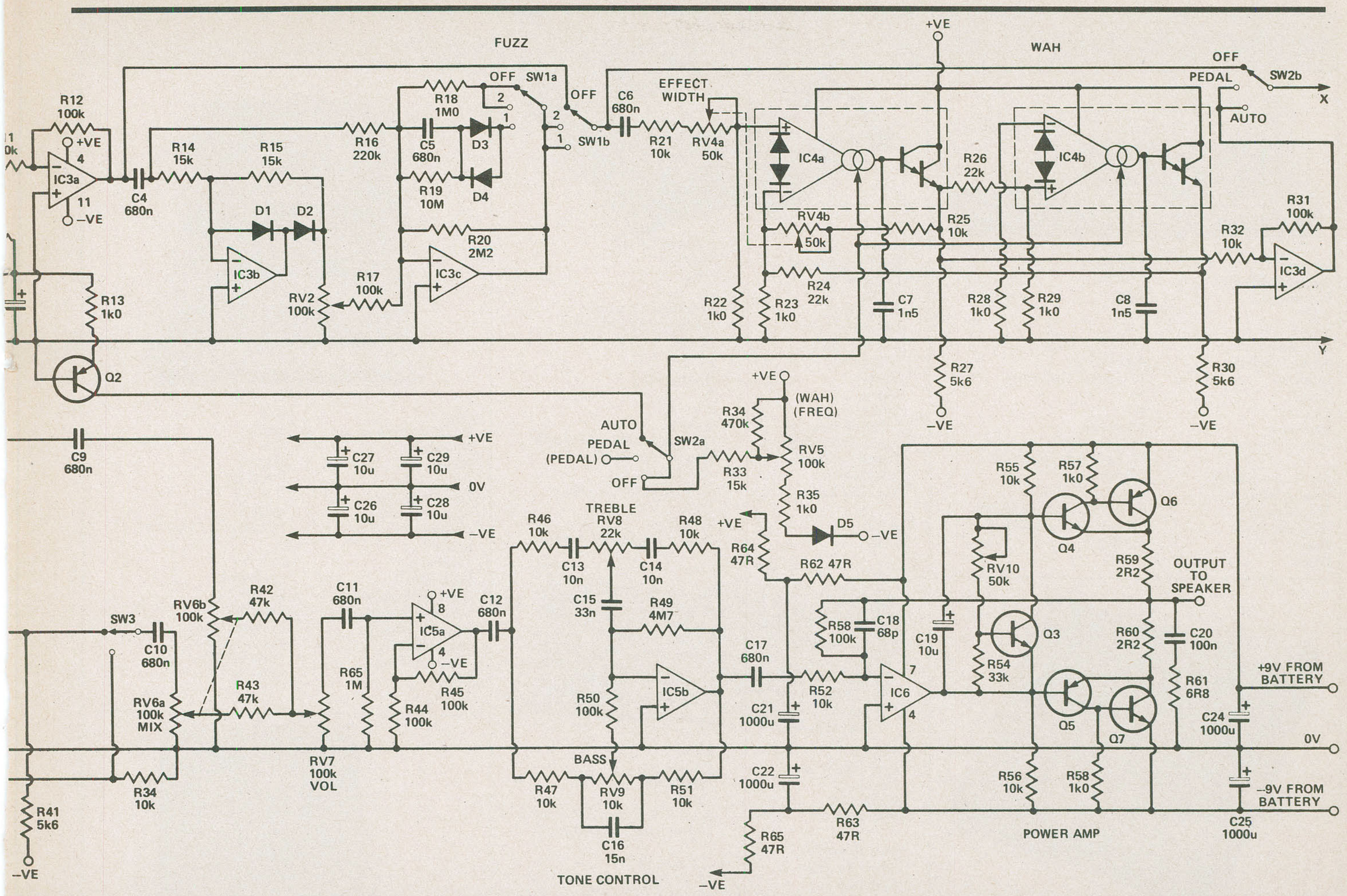
Fig. 6 Circuit diagram for the Playmate.



How it Works

The gain of the input buffer IC1 is set by R2 and R3 at 48. R1 determines the input impedance while C1 provides DC blocking. The output from this device goes to the dynamic range compressor IC2a and its buffer IC3a. This part of the circuit also provides control signals for the expander circuit and, if required, for the wah wah effect. The buffered output from the compressor then goes via C4 to the first part of the fuzz effect circuitry constructed around around IC3b. Here an inverted half-wave-rectified version of the input signal is produced by the action of D1 and D2 in the feedback network of IC3b. This is applied to RV1 from which a portion is selected and mixed with a little of the original signal. As the half-wave-rectified signal at this point of the circuit is twice as great as the straight-through signal, by varying the setting of RV1, amounts of distortion varying from none to virtual frequency doubling can be selected.

The mixture of signals obtained above is now applied to IC3c where they are amplified. The amount of amplification is determined by the setting of SW1. In position 3 minimum gain is provided and in fact the whole fuzz section is bypassed. Position 2 gives the same gain, allowing the first distortion stage to be effective. The final position connects D3 and D4 via C5 and R19 into the feeback circuit of IC3c instead of R18. This has the effect of greatly in-



creasing the small signal gain but causing the output to limit sharply, thus clipping and squaring the output. This facility is available on whatever output is coming from IC3b.

The output from the fuzz stages now passes to the wah wah. This effect is produced by the current controlled state variable filter used in a band-pass mode. The filter is realised by using a LM13600 device with a controlled bias current providing the variable centre frequency. The 'Q' factor is controlled by a dual gang potentiometer, half of which is used to control the 'Q' factor while the other half compensates for the effective gain change as this is altered. In this type of circuit the frequency range is determined by the values of C7, C8, R24 and R26, while the actual centre frequency is controlled by the amplifier bias current. If the bias current is allowed to become too small it is sometimes found that a thump is heard at the output; in order to prevent this R34, R35, D5 and R33 are used in the control circuitry to keep the current above this threshold.

SW2 selects between the control options for the wah wah circuit. The 'off' position bypasses the circuit altogether, the 'pedal' position makes access to an external foot pedal if fitted, while the 'auto' position connects to an output from the compressor stage. This control signal is a current which is proportional to the amount of signal compression being applied to the input signal. The magnitude of this current increases as the input signal increases. The result of this is that when the input signal is loud, the wah wah centre frequency is high and as the input decays, the wah wah frequency decreases with it. The effect of this is to make a wah sound automatically whenever a string or chord is played.

The output from this section is buffered and adjusted in level by IC3d. After this the signal passes to the signal expansion stage built around IC2b. C23 provides DC isolation and R36 converts the input voltage to a suitable drive current for the IC. For this application the linearising diode current is held constant while the amplifier bias current is varied. Q1 in the compressor circuit provides the control current for this stage allowing a good match in the attenuation/gain characteristics of the two stages. SW3 selects either the output from the expander or bypasses it as required to give normal or sustain on the effects channel.

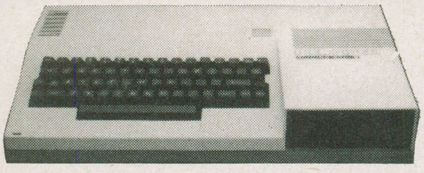
A dual gang potentiometer RV4 allows mixing between the original signal and the effect-modified signal. This is followed by a volume control RV5 to set the output sound level.

After the volume control, IC5a buffers the signal before applying it to the tone control circuit around IC5b. The configuration used here is a very common type of feedback arrangement. As an approximation, the gain of an op-amp with feedback is taken as —(feedback resistor value)/(input resistor value). If we replace the feedback and input resistors with variable impedances, we find that when the feedback impedance is greater than the input impedance then the overall gain is greater than unity, and vice versa. As impedances vary with frequency, the gain at each frequency will tend to be different. The only time the gain does not vary is when the input and feedback impedances are equal whatever their magnitude. This is the general principle on which the tone control networks operate.

The final section to be considered is the power amplifier stage. Voltage amplification is provided by IC6 and the output from it drives two complementary compound Darlington pairs, Q4/Q6 and Q5/Q7. Quiescent current through the output devices is set by RV8 in conjunction with Q3, R54 and C19. R59 and R60 aid in maintaining bias stability and provide some protection to the output transistors in the event of a fault. R61 and C20 compensate for load impedance variations at high frequency and C18 reduces the high frequency gain of the power amplifier to reduce the possibility of RF oscillation. The large capacitors C21-25 are to reduce the effects of aging batteries and prevent low frequency oscillation or intermodulation distortion.

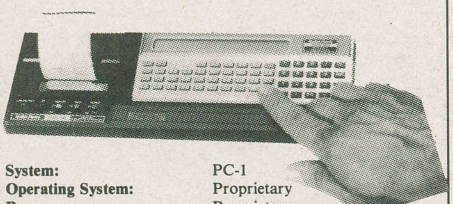
The construction details, parts list and overlays will appear next month. ETI

Computer Survey

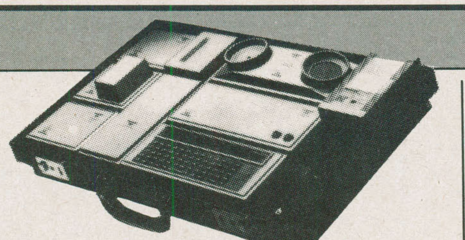


System:	Pied Piper
Operating System:	CP/M
Processors:	Z80A
RAM:	64K
Printer I/O:	P
Disk Drives Inc:	One 5¼" floppy
Screen Format:	40x24 (TV)
Graphics:	10 Graphic Characters
Sound:	N
Colour:	N
Keyboard:	Integrated
Software Included:	BASIC, Perfect Writer/Speller/Filer/Calc
Software Available:	Extensive
Primary Market:	Home or Business
Manufacturer:	Semi-Tech Microelectronics
Available From:	To be announced in Sept.
Price:	$1900.00
Other:	

System:	PC-4
Operating System:	BASIC
Processors:	Proprietary
RAM:	5K
Printer I/O:	$109.95
Disk Drives Inc:	Cassette $54.95
Screen Format:	12 charater LCD
Graphics:	N/A
Sound:	N
Colour:	N
Keyboard:	Qwerty
Software Included:	BASIC
Software Available:	
Primary Market:	Business or home
Manufacturer:	Tandy
Available From:	Radio Shack
Price:	$99.95
Other:	1K RAM module



System:	PC-1
Operating System:	Proprietary
Processor:	Proprietary
RAM:	1.9K
Printer I/O:	Radio Shack only
Disk Drive:	No
Screen Format:	24 char. LCD
Graphics:	No
Sound:	No
Colour:	No
Keyboard:	Calculator style
Software Inc.:	BASIC
Software Avail.:	Limited
Primary Market:	Home and business
Manufacturer:	Tandy
Available From:	Radio Shack
Price:	$159.95



System:	Panasonic HHC
Operating System:	Snap
Processors:	6502
RAM:	8K
Printer I/O:	Peripheral Connector
Disk Drives Inc:	RAM Modules available
Screen Format:	26 Char LCD
Graphics:	159x8
Sound:	N
Colour:	N
Keyboard:	Qwerty
Software Included:	Snap
Software Available:	Panasonic software available
Primary Market:	Home or Business
Manufacturer:	Panasonic
Available From:	Computer book & supply center
Price:	$549.00
Other:	Built in rechargable batteries

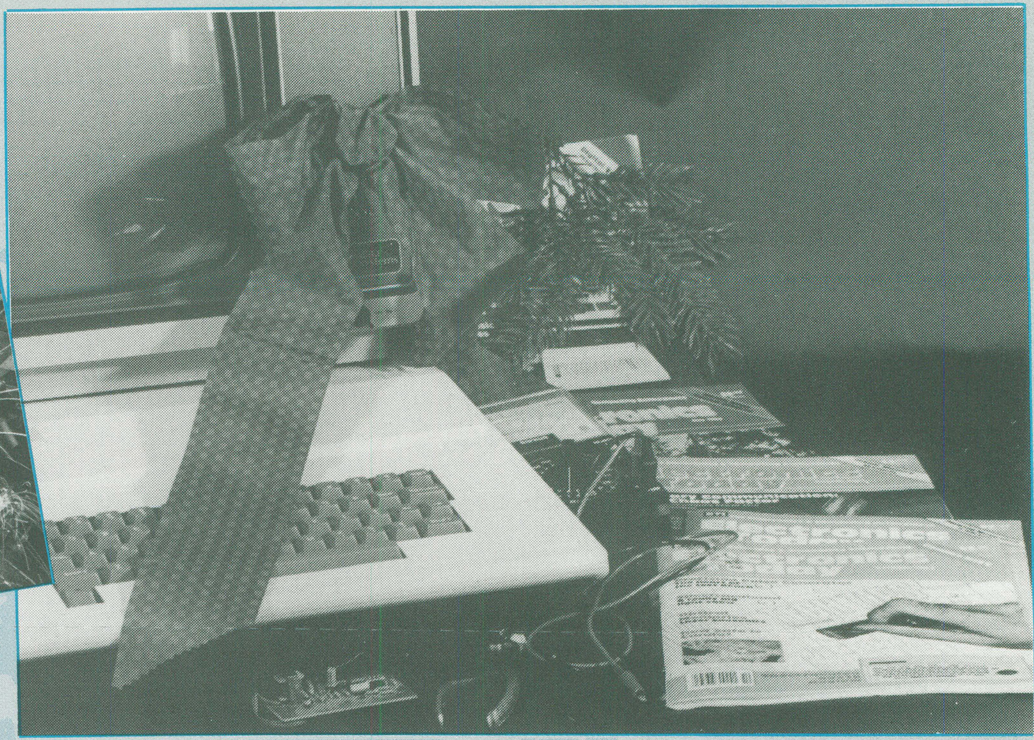
System:	PC-2
Operating System:	BASIC
Processors:	Proprietary
RAM:	2.6K
Printer I/O:	All-in-one printer/plotter/dual cassette interface $299.95
Disk Drives Inc:	
Screen Format:	7x156 LCD
Graphics:	N
Sound:	N
Colour:	N
Keyboard:	Qwerty
Software Included:	BASIC
Software Available:	Extensive
Primary Market:	Home or business
Manufacturer:	Tandy
Available From:	Radio Shack
Price:	$269.95
Other:	4 or 8K RAM module available

System:	Super 400
Operating System:	DOS
Processors:	6502
RAM:	48K
Printer I/O:	S, P & 8 Exp.
Disk Drives Inc:	Opt. Diskettes
Screen Format:	40x24
Graphics:	192x180
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	DOS
Software Available:	Extensive
Primary Market:	Home or business
Manufacturer:	Arcomp, Montreal
Available From:	Chen Koll
Price:	$650.00
Other:	Apple Compatible

System:	4032
Operating System:	BASIC
Processors:	6502
RAM:	32K
Printer I/O:	P & IEEE
Disk Drives Inc:	
Screen Format:	40x25
Graphics:	128 Graphic Characters
Sound:	Y
Colour:	N
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	Extensive
Primary Market:	Teaching tool
Manufacturer:	Commodore
Available From:	Local dealers
Price:	$1095.00
Other:	

System:	8032
Operating System:	BASIC
Processors:	6502
RAM:	32K
Printer I/O:	P & IEEE
Disk Drives Inc:	
Screen Format:	80x25
Graphics:	128 Graphic Characters
Sound:	N
Colour:	N
Keyboard:	Integrated
Software Included:	BASIC
Software Available:	
Primary Market:	Business or home
Manufacturer:	Commodore
Available From:	Local dealers
Price:	$1395.00
Other:	

System:	Oric 1
Operating System:	BASIC
Processor:	6502
RAM:	48K
Printer I/O:	Yes
Disk Drive:	Yes
Screen Format:	N/A
Graphics:	Med. res.
Sound:	Yes
Colour:	Yes
Keyboard:	Integrated
Software Inc.:	BASIC
Software Avail.:	Limited
Primary Market:	Personal
Manufacturer:	Oric, U.K.
Available From:	Gladstone
Price:	$399.00



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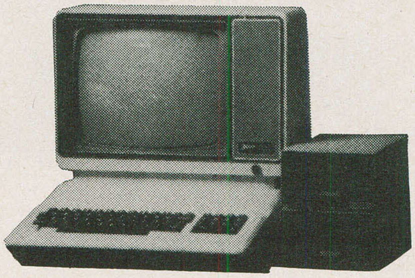
System: SV 318
Operating System: BASIC
Processors: Z80A
RAM: 32K
Printer I/O: Peripheral & Exp. Bus
Disk Drives Inc: Opt. floppy, cassette, or cartridge
Screen Format:
Graphics:
Sound: Y
Colour: Y
Keyboard: Integrated, Qwerty
Software Included: BASIC
Software Available: Extensive
Primary Market: Home
Manufacturer: Spectravideo, Hong Kong
Available From: Spectravideo
Price: $379.75
Other: Built-in cursor control Joystick

System: Multiflex System
Operating System: CP/M
Processor: Z80
RAM: 64K
Printer I/O: Yes
Disk Drive: Yes
Screen Format: N/A
Graphics: No
Sound: No
Colour: No
Keyboard: Optional
Software Inc.: None
Software Avail.: Extensive
Primary Market: Business
Manufacturer: Exceltronix
Available From: Exceltronix
Price: $994.00

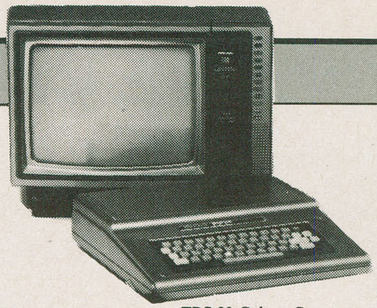
System: SuperPET
Operating System: Basic
Processors: 6502 & 6809
RAM: 96K
Printer I/O: S & IEEE
Disk Drives Inc:
Screen Format: 80x25
Graphics: 128 Graphic Characters
Sound: N
Colour: N
Keyboard: Integrated
Software Included: Waterloo APL/BASIC/COBOL/ FORTRAN/PASCAL
Software Available: Extensive
Primary Market: Teaching tool
Manufacturer: Commodore
Available From: Local dealers
Price: $1795.00
Other:



System: TK 8000
Operating System: Basic
Processors: 6502
RAM: 48K
Printer I/O: 7 Board Connector
Disk Drives Inc: Opt cassette or drives
Screen Format: 40x24
Graphics: 280x192
Sound: Y
Colour: Y
Keyboard: Integrated
Software Included: BASIC (integer and Applesoft)
Software Available: Extensive
Primary Market: Home or Business
Manufacturer: Chen Enterprize
Available From: C & H Electronic's Plus
Price: $699.00
Other: CP/M Opt

System: TRS MC-10
Operating System: BASIC
Processors: 6803
RAM: 4K
Printer I/O: S
Disk Drives Inc: Optional cassette
Screen Format: TV
Graphics: Block
Sound: Y
Colour: Y
Keyboard: Integrated, Qwerty
Software Included: BASIC
Software Available: Extensive
Primary Market: Home
Manufacturer: Tandy
Available From: Radio Shack
Price: $199.95
Other: Printer available, expandable to 20K

System: TRS-80 Model 100
Operating System: Proprietary
Processor: 80C85
RAM: 8K
Printer: I/O: Yes
Disk Drive: No
Screen Format: 40 X 8 LCD
Graphics: Block
Sound: Yes
Colour: No
Keyboard: Integrated
Software Inc.: BASIC, telecom, textfiles, etc.
Software Avail.: Limited
Primary Market: Home and business portable
Manufacturer: Tandy
Available From: Radio Shack
Price: $1099.00



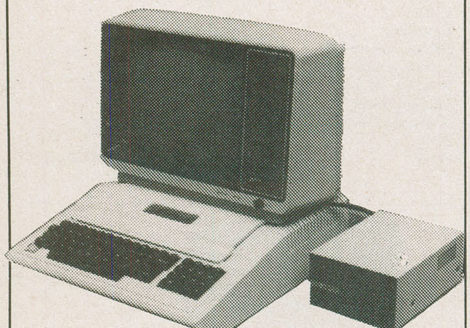
System: TRS-80 Colour Computer
Operating System: BASIC
Processors: 6809E
RAM: 16K
Printer I/O: S
Disk Drives Inc: Optional disks or cassettes
Screen Format: 16x32
Graphics: 192x256
Sound: Y
Colour: Y
Keyboard: Integrated
Software Included: BASIC
Software Available: Extensive
Primary Market: Home
Manufacturer: Tandy
Available From: Radio Shack
Price: $449.00
Other: Optional Joystick, Mouse, & Multipack Interface

System: Tiger 4000
Operating System: DOS
Processors: 6502 & Z80A
RAM: 64K
Printer I/O: 8 slots
Disk Drives Inc: Cassette
Screen Format: 40x24
Graphics: 280x192
Sound: N
Colour: N
Keyboard: Integrated
Software Included: Spreadsheet, word processor
Software Available: Extensive
Primary Market: Home or Business
Manufacturer: TEO Computers
Available From: TEO Computers
Price: $849.00
Other: Apple compatible, CP/M upgradable

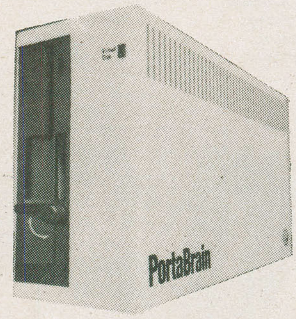
System: TPC 8300
Operating System: Ext Basic
Processors: CMOS
RAM: 6K
Printer I/O: P
Disk Drives Inc: Printer-plotter-cassette inteface available
Screen Format: 48x2 LCD
Graphics: 255 Graphic Characters
Sound: N
Colour: N
Keyboard: Qwerty
Software Included: Extended pocket BASIC
Software Available: 10 free programs included
Primary Market: Business
Manufacturer: TEO Computers
Available From: TEO Computers
Price: $499.00
Other: Portable, battery or adaptor power

Computer Survey

System:	TI99 4A
Operating System:	BASIC
Processor:	TMS9900 16-bit
RAM:	16K
Printer I/O:	No
Disk Drive:	No
Screen Format:	32 X 24
Graphics:	Block
Sound:	No
Colour:	No
Keyboard:	Integrated
Software Inc.:	TI BASIC
Software Avail.:	TI ROM Packs
Primary Market:	Personal
Manufacturer:	Texas Instruments
Available From:	Local dealers
Price:	$499.95

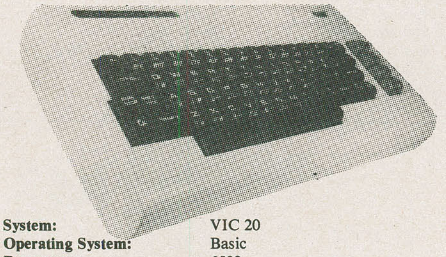


System:	Unitron
Operating System:	MSDOS
Processors:	6502
RAM:	48K
Printer I/O:	8 Exp. slots
Disk Drives Inc:	Opt. cassette or floppy
Screen Format:	80x25
Graphics:	Medium Res.
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	MSDOS
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Unitron Computer Corp.
Available From:	Unitron Computer Corp.
Price:	$1349.00
Other:	Apple Compatible

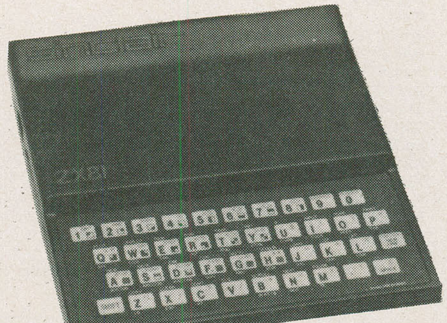


System:	UR Portabrain
Operating System:	CP/M
Processors:	Z80A
RAM:	64K
Printer I/O:	2 S & P
Disk Drives Inc:	5¼" floppy, RAM disk (192K)
Screen Format:	N/A
Graphics:	N/A
Sound:	N/A
Colour:	N/A
Keyboard:	N/A
Software Included:	CP/M & Communications Package
Software Available:	Extensive
Primary Market:	Business
Manufacturer:	Universal Research
Available From:	Micro Bazzar
Price:	$1495.00
Other:	Portable

System:	VZ 200
Operating System:	BASIC
Processors:	6502
RAM:	4K
Printer I/O:	Peripheral expansion bus
Disk Drives Inc:	cassette
Screen Format:	32x16
Graphics:	128x64
Sound:	Y
Colour:	Y
Keyboard:	Moving-key rubber
Software Included:	BASIC
Software Available:	Extensive by Video Technology Ltd.
Primary Market:	Home
Manufacturer:	Video Technology Ltd
Available From:	Rocelco Inc.
Price:	$179.50
Other:	



System:	VIC 20
Operating System:	Basic
Processors:	6502
RAM:	5K
Printer I/O:	S
Disk Drives Inc:	Opt cassette or cartridge
Screen Format:	22x23
Graphics:	178x184
Sound:	Y
Colour:	Y
Keyboard:	Integrated
Software Included:	BASIC, game
Software Available:	Extensive
Primary Market:	Home
Manufacturer:	Commodore
Available From:	Local dealers
Price:	$319.95
Other:	



System:	ZX81
Operating System:	BASIC
Processor:	Z80
RAM:	1K
Printer I/O:	Sinclair only
Disk Drive:	No
Screen Format:	32 x 24
Graphics:	Block
Sound:	No
Colour:	No
Keyboard:	Membrane
Software Inc.:	ZX BASIC
Software Avail:	Extensive
Primary Market:	Personal
Manufacturer:	Sinclair/Timex
Available From:	various dealers
Price:	$69.95

Chen Koll, 3987 Chestwood Dr., Downsview, Ontario, M3J 2R8. (416) 636-2116.

C & H Electronic's Plus, 23 Passmore, Unit 11, Scarborough, Ontario, M1V 2V8. (416) 292-0813.

Computer Book & Supply Center, 253 Eglinton Ave. West, Toronto, Ontario. (416) 489-3625.

Dragon Data (Canada) Ltd., Continental Bank Building, 130 Adelaide St. West, Suite 1818, Toronto, Ontario, M3H 3P5. (416) 947-9052.

Electronic Playworld, 1726 Avenue Rd., Toronto, Ontario, M5M 3Y6. (416) 789-3596.

Essna Services Ltd., 31 Progress Court, Unit 1, Scarborough, Ontario, M1G 3V5. (416) 438-8060.

Exceltronix, 319 College St., Toronto, Ontario, M5T 1S2. (416) 921-8941.

Franklin Ace Computers, 1941 Leslie St., Don Mills, Ontario, M3B 2M3. (416) 449-9339.

Gladstone Electronics, 1736 Avenue Rd., Toronto, Ontario, M5M 3Y7. (416) 787-1448.

Hewlett Packard, 6877 Goreway Drive, Mississauga, Ontario, L4V 1M8. (416) 678-9430.

Interactive Micro Systems, 22 Strathearn Ave., Unit 6, Brampton, Ontario. (416) 791-0543.

Irwin Electronics, 165 North Queen St., Etobicoke, Ontario. (416) 626-6600.

Micro Bazaar, 23 Westmore Dr., Unit 5, Rexdale, Ontario, M9V 3Y7. (416) 745-4740.

Micos Computer Systems Inc., 1295 Eglinton Ave. East, Cooksville, Ontario, L4W 3E6. (416) 624-0320.

Micro Computers of Canada Inc., 3410 Midland Ave., Unit 6, Scarborough, Ontario. (416) 293-3885.

Orion Electronics Supplies Inc., 40 Lancaster West, Kitchener, Ontario, N2H 4S9. (519) 576-9902.

Polytech Int. Canada Ltd., 1262 Don Mills Rd., Suite 92, Don Mills, Ontario, M3B 2W7. (416) 445-4270.

Radio Shack Computer Centre, 329 Bay St., Toronto, Ontario. (416) 365-7207.

SGV Marketing 1520 Trinity Dr. Unit 16, Mississauga, Ontario, L5T 1T6. (416) 673-2323.

Spectravideo, 2913 Lakeshore Blvd. West, Toronto, Ontario, M8V 1J3. (416) 252-4550.

Spiral Computers, 473 Church St., Toronto, Ontario, M4V 2C5. (416) 927-8440.

Teo Computers & Peripherals Inc., 218 Yorkland Blvd., Willowdale, Ontario, M2J 1R5. (416) 493-8558.

Total Office Systems Ltd., 1050 McNicoll Ave., Unit 14, Scarborough, Ontario, M1W 2L8. (416) 493-3575.

Unitron Computer Corp., 298 Dundas St., London, Ontario, N6B 1T8. (519) 672-3806.

ETI

optical components in quantity. They have developed a rocket driven magneto-hydrodynamic (MHD) generator which produces 15 megawatts of short term electric power, a device which has no counterpart in the West. The Soviets have committed to development moderate-power systems capable of short range ground-based applications such as tactical air defense and antipersonnel weapons. It is believed that by the latter half of this decade, it is possible that the Soviets could produce laser weapons for several other ground, ship and aerospace applications.

In response to the perceived threat, the US re-introduced studies in high energy weapons systems (including particle-beam weapons) under the aegis of the Defense Advanced Research Projects Agency (DARPA). Simultaneously, the three forces commenced studies of their own. While complementary in some respects, these were being designed for different end-user functions.

Army-Navy Game

The Army, for instance, has two weapon systems under research and development: one, a lower power system, is designed to "craze" the optical and infrared sensors of missiles and divert them from their targets. The other, a higher-powered system, would destroy helicopters on the NATO front. The Army's success to date, at least publicly, was the destruction of winged and helicopter drones at the Redstone Arsenal, Alabama, in 1976.

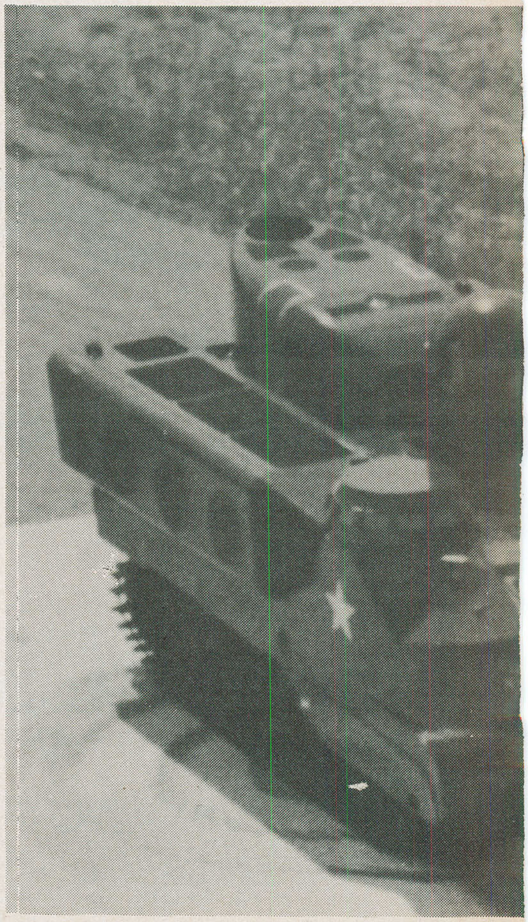
The Navy's perception of the utility of such weapons is primarily point defense of ships, whereby a single laser (code names **Sea Lite**) would be computer controlled to focus and aim a beam and keep it steady until a series of targets had been destoryed. As such, the primary thrust of their research has been in perfecting the computer controlled sub-systems. DARPA, in general, needs a similar capability for the space-based laser fire-control and tracking system in order to knock out batches of oncoming intercontinental ballistic missiles long before they have reached earth orbit and are able to release their weapons. Their major public success to date was when a chemical laser of moderate power developed by DARPA, combined with a Navy developed pointer/tracker, successfully engaged and destroyed in flight a TOW antitank missile launched by a crew of Army technicians. This test was part of the Unified Navy Field Test Program conducted at San Juan Capistrano, California, at a site near Camp Pendleton in 1978.

It is the Air Force, however, under their newly created Space Command, which has done most of the non-DARPA work. Their efforts have been to develop a way to prevent vibration aboard an aircraft when a laser is shooting photons at a power level of more than 1 million watts. Vibration upsets the alignment of the mirrors that focus and reflect the laser's beam and keep it steady until a series of targets had been destroyed. As such, the primary thrust of their research has been in perfecting the compuer controlled sub-systems. They have two published successes. The first was in 1973, when they used a high energy gas-dynamic laser of moderate power and an on-gimbal telescope to shoot down a winged drone at the Sandia Optical Range at Kirtland AFB, New Mexico. Most recently, in July of this year, the Air Force used an airborne laboratory aboard a converted NKC-135 plane to successfully destroy five **Sidewinder** missiles travelling at 3,000 km/hour fired at it by an A-7 fighter-bomber.

Space Lasers

Next to Air Force expenditures, the largest proportion of the almost half billion dollars being spent in 1984 on High Energy Laser (HEL) research is being spent by DARPA for its space battle station. Their main interest is in the development of a space battle station for strategic purposes. One of the main problems they face is the optical tracking and locking-in process, code named Project Alpha in general, with the tracking unit known as Talon Gold. Talon Gold has shown enough promise that it is expected to be tried aboard the space shuttle some time in 1986 or 1987.

DARPA officials are optimistic that the laser battle station they are planning will be able to shoot down enemy satellites, submarine launched missiles or flights of bombers. But such objects will be sitting ducks compared to countering land-based intercontinental missiles which could be launched by the hundreds or thousands at the US and must be destroyed in the early moments of flight. The cost of such a shield would be enormous, involving at least several tens of such battle stations and "at least 200 billion dollars", according to Pentagon sources. To reduce the cost, there is some thought that DARPA should abandon its chemical laser work and concentrate on developing X-ray or free-electron lasers, work that is currrently being pursued at Avco Corp and at the Defense Department's Lawrence Livermore and Los Alamos Laboratories. Because free-electron lasers are able to transmit power at shorter wavelengths than gas dynamic or chemical lasers, they should permit the design of smaller weapons, but to generate power, they need vast amounts of either electrical or nuclear energy. Moreover, short wave-



length lasers also need very precise optical subsystems that are not now available.

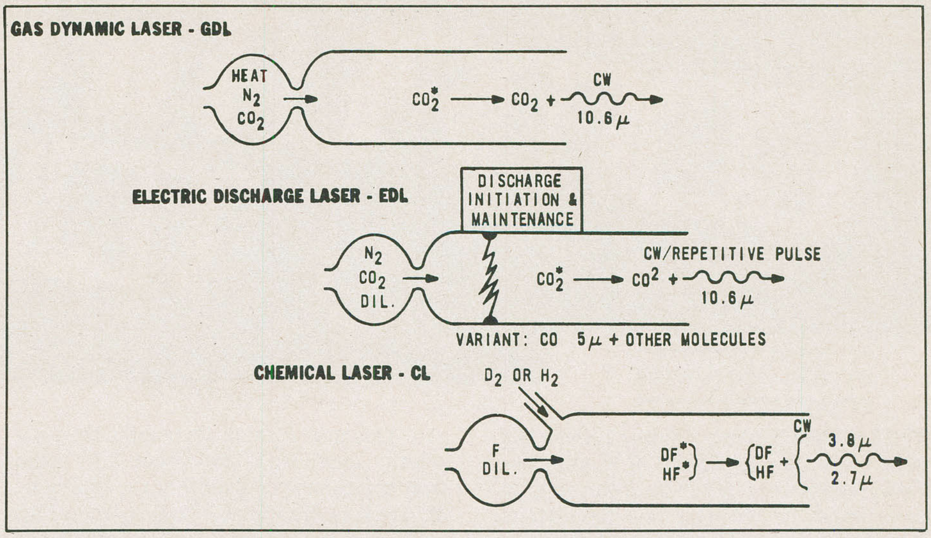
Reality Steps In

Yet when all is said and done, it appears that while the Army can knock down helicopters and the Air Force **Sidewinder** missiles, the potential for a space battle station to actually work is almost negligible. There are two main reasons. The first is atmospheric interference, even allowing for the considerable problems of storing and generating enormous bursts of energy, aiming the weapons and verifying that the target has been hit. Moreover, effective countermeasures against lasers are known, and it is likely that they could be devised for future weapons of this genre.

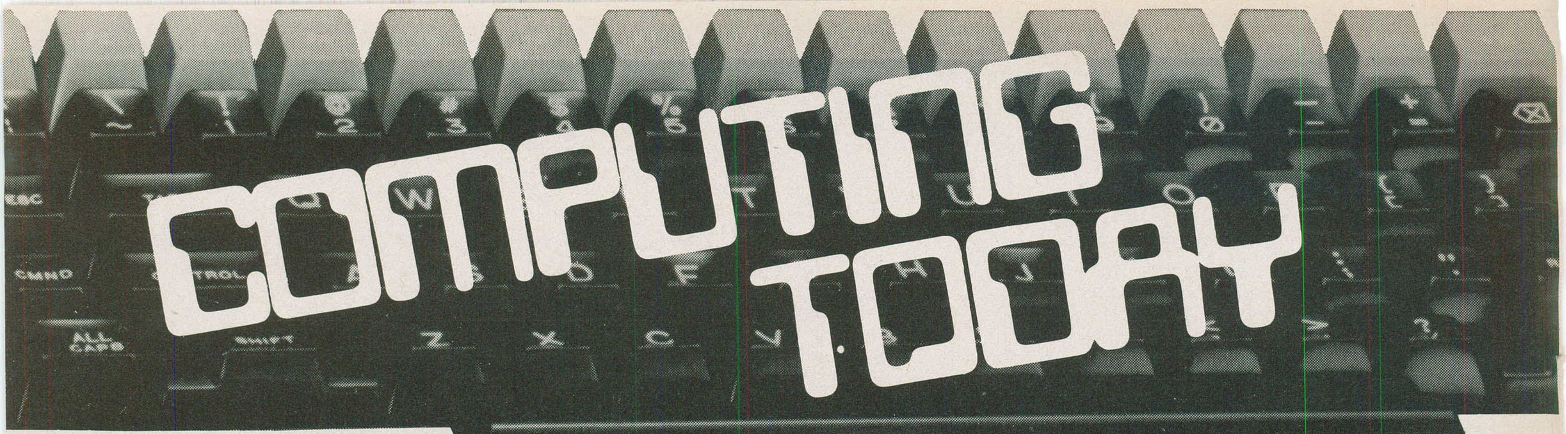
However, the most effective countermeasure against satellites, whether battle stations or communications satellites, is also the most chilling form of space warfare, namely the detonation of a nuclear weapon in space. Such explosions are expressly prohibited by the 1963 Partial Test Ban Treaty, but military analysts have nonetheless become anxious about the effect of nuclear explosions on satellite weapons systems.

Gamma rays and other forms of high energy radiation from a nuclear explosion would expel electrons from the metal skin of a satellite and thereby generate an electric field inside the satellite, the potential of which could reach a million volts per metre. The electric field would disrupt or destroy the electronic circuitry of the satellite. The effects of a one-megaton explosion would extend through a spherical volume of space 50,000 kilometres in diameter. Any unprotected satellite in this range, but not in the radiation shadow of the earth, would be made useless by the explosion (see **Military Communication: The Chaos Factor**, ETI, Aug. 1983).

Unless these two problems can be overcome, which is highly unlikely, President Reagan's hope that lasers and other particle-beam technology can be employed by the end of the century to render strategic nuclear weapons obsolete seems just so much chaff. ETI



Three types of lasers used in weaponry.



by Bill Markwick

THIS MONTH Steve Rimmer is occupied with his duties as editor of Computing Now! magazine. He'll be returning to these pages in the next few months, as long as he promises not to use the word "ginchy" more than five times per page. We present instead a short overview of FORTH, a fascinating computer language that is slowly becoming more popular as people find out about its unique characteristics:

1. Reverse Polish Notation, surely the most efficient way to do calculations.
2. Speed approaching assembly code.
3. A "dictionary" which stores whatever commands you define.

The language was originally created by Charles Moore as an aid to astronomers who needed simple rapid control of instruments, but it soon spread into the world for general-purpose use. There have been many versions over the years, each change making the language easier to use or suiting it to a specific computer, but there are enough similarities to allow a generic approach.

RPN

Let's start with the RPN. You'll be familiar with this if you have a Hewlett-Packard calculator. Any numbers you enter will be held in the "stack", a last-in first-out storage register. The HP stack can hold four numbers for later manipulation, but for most purposes, FORTH can be considered to have a bottomless pit. As you perform operations, usually between the top number and the one under it, the stack pops out the answer, or stores it, and moves up the next next number to the top. What makes RPN so efficient is that the mathematical operators are entered last; this eliminates the pesky "equals" sign, and removes any need for keeping track of nested parentheses. Here's a sample calculation:

```
20 30 40 + -. RETURN
-50 OK
```

The three numbers were pushed into the stack, with 40 being last in; this puts it at the top. The plus sign added 30 and 40 to give 70, and then subtracted 70 from 20. The dot command means "display stack-top", and it displayed the answer.

This may seem more trouble than it's worth; there isn't any great advantage over algebraic calculation at the moment. Where it really shines is in long equations such as network analysis or impedance calculations. It becomes such a delight to use that you'll never want to see the "equals" sign again.

As far as speed goes, FORTH accomplishes its rapidity by being halfway between an interpreter and a compiler. When you enter something, a section called the interpreter checks to see if it's a string, i.e., an instruction. This interpreter is a bit different from the BASIC type, which converts each instruction to machine code by performing little subroutines ("print", for instance); instead, the dictionary is checked to see if the command is there. If so, it's performed. If not, a section which handles numbers is called in, and the numbers put on the stack. If it isn't either, an error code is printed.

Dictionary Definitions

This brings us to the most fascinating aspect of FORTH, the dictionary function. It allows you to define commands and store them; they become part of the language, and each user then has his own personalized FORTH. Here's an example. Suppose you often need to square some numbers. Squaring is not a command in the FORTH dictionary, so you'd have to add it yourself. A colon tells FORTH that you're defining a new word. Call it "SQR".

```
: SQR ." THE SQUARE IS " DUP * . ;
```

What all this gibberish means is: "Print the message. Duplicate the number entered and multiply the two. Print the result." Now to use it:

```
10 SQR (RETURN) THE SQUARE IS 100 OK
```

Now type "VLIST" and you'll see all the words in the dictionary scrolling up. At the head will be your word "SQR". The possibilities are endless; you can define a word using other definitions, and end up with an actual mini-program that can be called up with just one word or symbol.

Looping

In BASIC, you can repeat an operation any number of times by using the FOR...NEXT loop. In FORTH, we use the DO...LOOP instruction. For instance:

```
: DEMO 10 0 DO CR . " LOOPING " LOOP ;
```

will print "LOOPING" ten times in a vertical column, because CR stands for carriage-return. The 10 and 0 are used to specify the number of loops; they could be any numbers. The . " symbol is a token for "PRINT". You may be dazzled by how fast the DO...LOOP is compared to the FOR...NEXT.

By the way, should you have the software handy and are doodling with examples, you have to be critical about spaces between words and symbols. FORTH is very fussy about this, unlike BASIC, which ignores spaces. If you keep getting error messages, chances are it's a space problem.

What's It Good For?

It's good for controlling any outside process, because the stack manipulations and logic operators are a natural for controllers of all types. It's good for situations where you need special custom commands not available in other languages. Its speed makes it ideal for graphics; it's a favourite for computer graphics in films or scientific applications.

But most of all, it's fun to use, despite the hassle of having to learn the somewhat uncomfortable syntax.

Getting Going

FORTH is available from a number of software dealers for a number of computers such as the Apple or TRS-80. You can even get it on cassette for the ZX81, from Gladstone Electronics, but keep in mind that FORTH (and its dictionary) was designed for disk systems, and the cassette effort will drive you crazy.

You'll probably want some good books on the language; the best one I've seen is 'Starting FORTH' by Leo Brodie, Prentice-Hall publishing. Most computer supply stores can advise you on software and documentation.

It's not the language for everyone and every use, but it's one of the most intriguing. ETI

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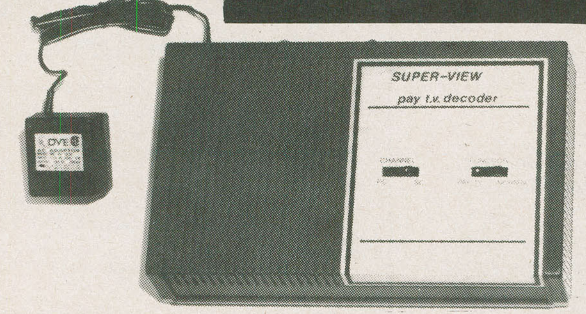

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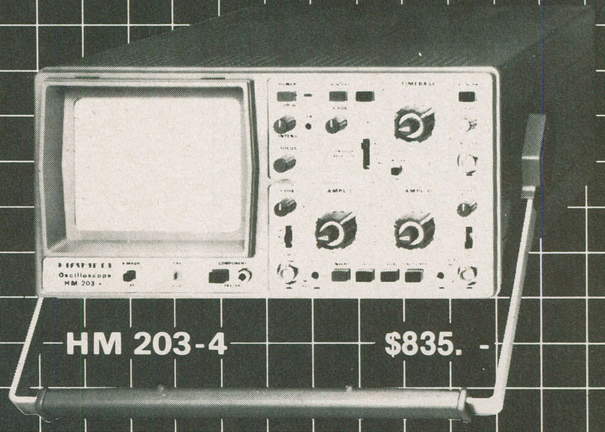

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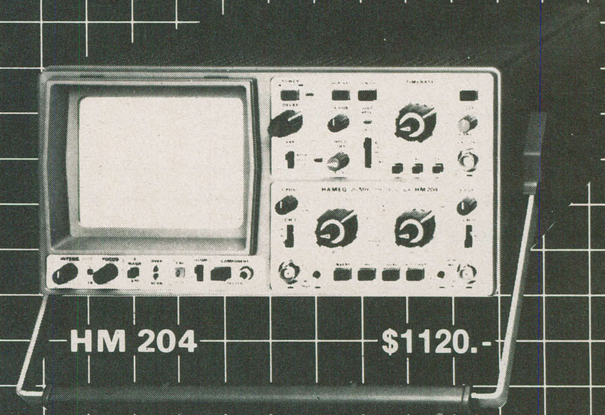

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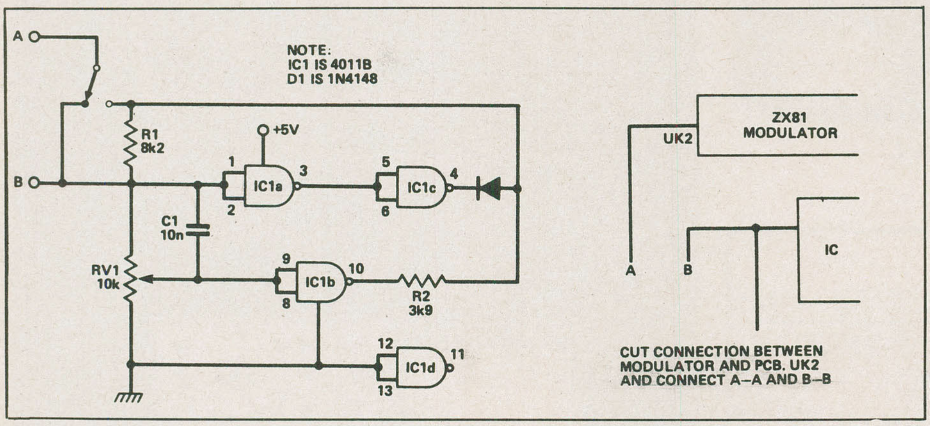
TECH TIPS

ZX81 Background Reverse
F.W. Picken

This simple circuit uses readily available (and cheap!) components to provide white symbols on a dark background. It can be put together on a small piece of circuit board which could then be housed inside the case of the computer and held in position by double-sided tape or epoxy.

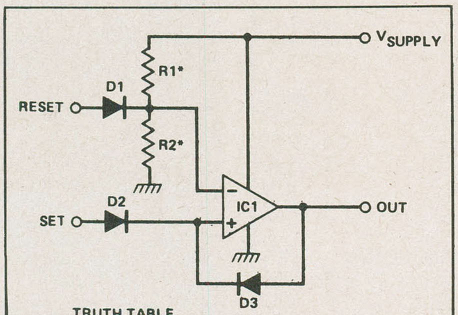
The change-over switch, used for switching from black symbols on white and vice versa, can be mounted on the side of the case, a push-on push-off type probably being the most suitable due to ease of mounting. The power requirement is very low, and can be taken from the ZX81 supply line.

Action of the circuit is very simple: IC1a and c carry the negative-going sync pulse and nothing else, thus ensuring that this is not inverted. The remainder of the video signal is inverted by IC1b. The value of RV1 needs careful setting to obtain the best results.



Analogue Set-Reset Latch
T.P. West

Although CMOS gates are commonly used to provide analogue amplifiers, the operational amplifier is often overlooked for use in digital applications. Often, a circuit design calls for a set-reset latch within an analogue circuit: this normally requires digital circuitry to be included in the design. By the use of this circuit, spare op-amps in a package may be utilized to provide the set-reset function. The op-amp used may be of any type with the low and high voltages at the output being only a function of the op-amp's internal output drive circuitry. The resistors R1 and R2 should be chosen so that $R2 = 2.4R1$ and $R2 < V_{supply}/0.05$. Although the circuit is shown for a single supply rail, it will work on a dual supply but produces a low of around the negative supply voltage. All changes in state occur on the low-to-high transition.



TRUTH TABLE

SET	RESET	OUT
0	0	NC
0	1	0
1	0	1
1	1	1

NC = NO CHANGE

*SEE TEXT

NOTE:
IC1 IS ANY OP-AMP
D1-3 ARE 1N4148

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